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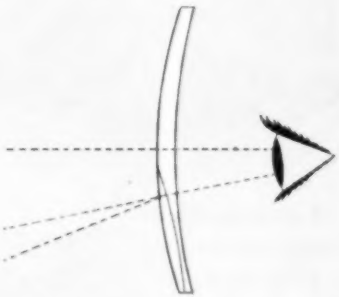

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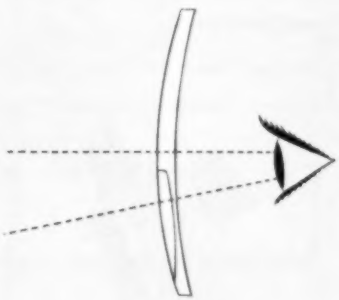

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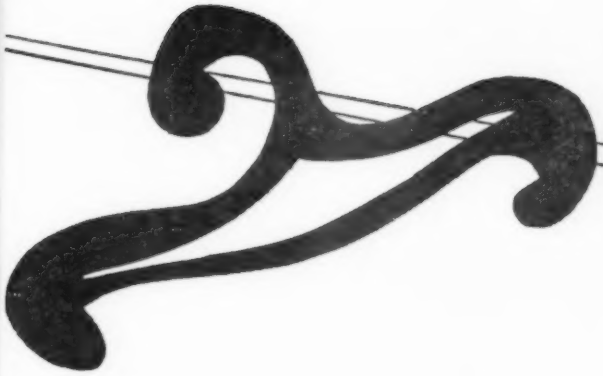

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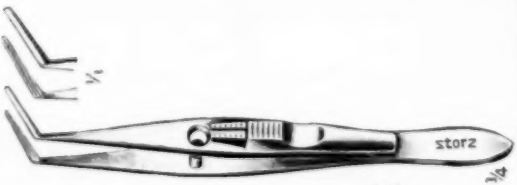

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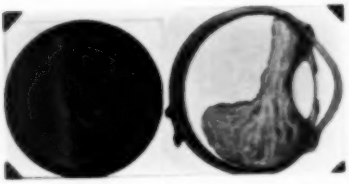
Frontispiece illustrating article by Dohrmann K. Pischel

FIG. A



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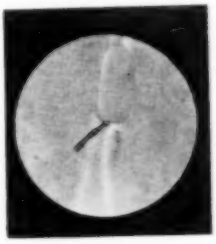

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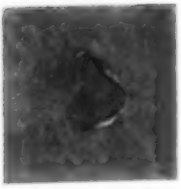
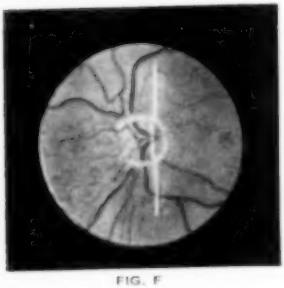


FIG. D

FIG. E



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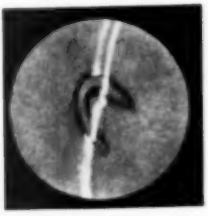

FIG. G

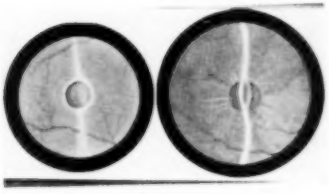

FIG. H

FIGS. A-H (PISCHEL). (FIG. A) DIAGRAMMATIC PICTURE OF GROSS ANATOMIC VIEW AND COMPOSITE SLITLAMP VIEW OF PARTIAL VITREOUS DETACHMENT WITH COLLAPSE IN THE POSTERIOR SUPERIOR QUADRANT.

(FIG. B) DIAGRAMMATIC PICTURE OF GROSS ANATOMIC VIEW AND COMPOSITE SLITLAMP VIEW OF COMPLETE VITREOUS DETACHMENT WITH COLLAPSE IN POSTERIOR SUPERIOR QUADRANT.

(FIG. C) DISCRETE RINGLIKE VITREOUS OPACITY IN POSTERIOR FACE OF VITREOUS REPRESENTING A HOLE IN THE POSTERIOR VITREOUS MEMBRANE (HRUBY).

(FIG. D) IRREGULAR DISCRETE RINGLIKE VITREOUS OPACITY, WITH ROLLED EDGES, IN POSTERIOR FACE OF VITREOUS AS IN FIGURE C (HRUBY).

(FIG. E) LARGE HOLE IN POSTERIOR VITREOUS FACE, WITH ADDITIONAL SMALLER HOLES.

(FIG. F) PARTIAL DETACHMENT OF VITREOUS. THE VITREOUS IS JUST PULLING LOOSE FROM ITS ATTACHMENT AT THE DISC, THE TEMPORAL HALF BEING ENTIRELY FREE (HRUBY).

(FIG. G) VITREOUS ADHERENT TO FLAP OF HORSESHOE-SHAPED TEAR IN CASE OF SIMPLE RETINAL DETACHMENT.

(FIG. H) LEFT: DEFINITE HOLE IN THE MACULA. RIGHT: CYST IN THE MACULA.

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DETACHMENT OF THE VITREOUS AS SEEN BY SLITLAMP EXAMINATION*

WITH NOTES ON THE TECHNIQUE OF SLITLAMP MICROSCOPY OF THE VITREOUS CAVITY

DOHRMANN K. PISCHEL, M.D.
San Francisco, California

INTRODUCTION

In the past the subject of the vitreous, from a clinical standpoint, has held little of interest to most ophthalmologists. From a scientific point of view, considerable knowledge of this tissue had been obtained. There was, however, little known of the changes found in the vitreous during life.

Due to its delicate nature the vitreous did not lend itself well to histologic examination of fixed and stained sections. In such specimens many artefacts occurred, and it was difficult to differentiate between true anatomic findings and those produced by the action of the various chemicals.

More recently examinations by means of the ultramicroscope have shown new findings, but still there has been no unanimity of opinion as to the structure of the vitreous. For example, Friedenwald and Stiehler[1] favor a membranous lamellar structure, rather than the fibrillar structure of earlier authors. Duke-Elder,[2] however, feels the vitreous is definitely a gel, with pseudofibers, and pseudomembranes visible with the slitlamp, which are due to the optical effect in the beam of light of the countless colloidal micella which make up the gel.

It is not my intention to go further into a discussion of these and other points of view, as this would demand almost a monograph on the subject. What will be taken up in this paper is the clinical examination of the vitreous and the findings which have been brought to light in recent years.

SLITLAMP EXAMINATION OF VITREOUS

Examinations of the vitreous by means of the slitlamp have been reported for many years. Kraupa,[3] Koeppe,[4] Vogt,[5] and Bedell[6] are a few of those who contributed to this field. They were perhaps more interested in the scientific findings from a microscopic standpoint than from that of application to clinical findings. Their examinations of the vitreous were also difficult and time-consuming, due to the instruments available in their time.

By means of the slitlamp alone only the most anterior portion of the vitreous is visible. The exact amount varies, being least in myopes and increasing in hypermetropes, so that one can see farthest into the eye in aphakic cases.

To enable one to see far back into the normal eye two changes must be made.

In the first place, the angle between the beam of light entering the eye, and the path of the beam of reflected light leaving the eye and entering the objective of the corneal microscope must be reduced to 17 degrees or less. To do this various devices have been evolved. The most common one was to mount a mirror on the end of the slitlamp arm (fig. 1) so that the light could be deflected into the eye at any angle desired (Koeppe and Kleefeld[4,7]).

In the second place, the refraction of the eye must be neutralized. This was first ac-

* Read in abstract form before the 88th Annual Meeting of the American Ophthalmological Society, Hot Springs, Virginia, June 6, 1952.

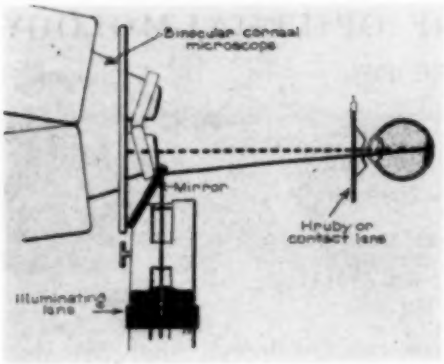

Fig. 1 (Pischel). Diagram of mirror, mounted on end of standard slitlamp arm, to reflect light into eye.

complished by Koeppe (fig. 2) by means of a contact glass, whose anterior surface was practically flat. This enabled one not only to see into the fundus of the eye, but to focus the slitlamp beam on the retina and any plane in the vitreous cavity. With this contact glass, one was limited as to the size of the field of observation in the fundus so that roughly only the posterior pole for a distance of about five disc diameters from the macula could be observed sharply.

Most recently, a substitute for the contact glass was advocated by Hruby.[8] This was the use of a lens of −55 diopters, which was held close in front of the eye. This is much simpler than the use of the contact lens. Furthermore, it enables one to see much further into the periphery than with the contact glass. Hruby feels one can see anterior to the equator. The advantages and disadvantages of this lens will be mentioned later.

With all of these aids, examination of the vitreous still was difficult. To focus the slitlamp beam accurately through a mirror was difficult enough. Any slight movement of the slitlamp arm changed the focus markedly. Then, using the other hand it was necessary to focus the corneal microscope on the same plane. This was difficult to do even on the retina where one could easily see the beam on a "solid" substance, and then focus both slit and microscope on this plane. To do this in the vitreous cavity where one had no such "solid" substance on which to focus was, if not well nigh impossible, at best time consuming and unsatisfactory.

Newer instruments

In recent years, routine examination of the vitreous in almost any patient has been made possible by the development of newer instruments. Lindner's offset microscope[9] enabled one to use the standard Zeiss or Bausch and Lomb slitlamp fairly easily for such examinations. However, it was due to the development by Goldmann[10] of the slitlamp bearing his name (and produced by Haag-Streit of Berne, Switzerland) that the slitlamp examination of the vitreous was so simplified that it became possible to do it with ease and with little expenditure of time.

All the important features and improvements of this lamp cannot be mentioned. However, one of them worth stressing is the use of a four-sided prism (with double internal reflection), mounted on the end of the slitlamp arm beyond the illuminating lens, for reducing the angle between the light entering the eye and the axis of the observing microscope (fig. 3).

By means of this Goldmann prism, this

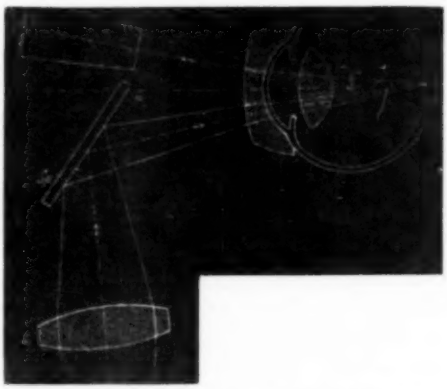

Fig. 2 (Pischel). Diagram of contact glass (after Koeppe) and mirror (after Kleefeld) for examining the fundus. (Sp) Mirror; (L) illuminating lens of slitlamp.

angle can be reduced to as little as 13 degrees. This is a great improvement over a Koeppe or Kleefeld mirror.

But the most important feature for the examination of the vitreous that this slitlamp possesses is the coupling together of the movement of the illuminating system with the movement of the microscope. To do this the slitlamp beam and the microscope are initially focused on one point. From then on they are both moved about by means of a small hand lever which moves them absolutely together. When one wishes to focus more deeply into the eye, the lever is simply pushed forward and the microscope and beam of light are carried forward together, remaining focused on the same plane. The same holds true for changing position in any other direction desired.

This factor is of utmost importance in examining the vitreous. Usually the structures in the vitreous are so nearly transparent that they can only be seen when the slitlamp beam and the microscope are very accurately focused upon them. However, to focus accurately the beam and the microscope separately on such fine structures as are seen in the vitreous is practically impossible, for they would only be visible at the moment both happened to be focused on the same plane. It is, therefore, necessary first to focus microscope and beam on the same point in some easily visible structure, such as the cornea, lens, or retina; then, in further focusing, the relative setting of lamp and microscope must remain absolutely unchanged.

In this way then, the vitreous cavity can be easily explored with the slitlamp, and the filmiest structure encountered can be examined in sharp focus both as to microscope and beam with no further adjustments being necessary.

Considerable space has been devoted to explaining this one feature, because it is the crucial factor in making possible the easy examination of the vitreous.

All new slitlamp models have incorporated this important feature in their design. This

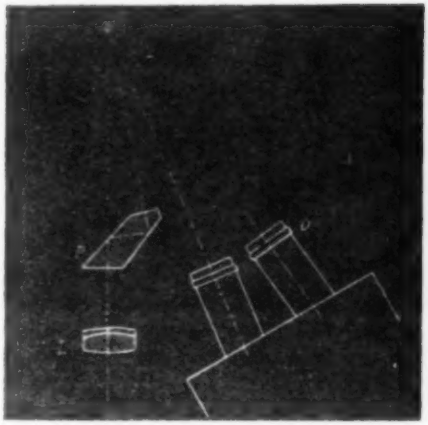

Fig. 3 (Pischel). Diagram of "Goldmann prism," with microscope to show reduction in angle between beam of light and line of observation. (I) Illuminating of slitlamp; (P) Goldmann prism; (O) corneal microscope.

holds true for the new Zeiss slitlamp, the various English ones, as well as French and Italian models. Thus with any of the new instruments the simplified examination of the vitreous is made possible.

Yet, although the examination of the vitreous cavity is simplified, it is still not easy even for an experienced slitlamp microscopist who is attempting it for the first time. Just as practice was necessary when a slitlamp was first used to examine the cornea and lens, so again considerable practice will be needed by everyone before all details in the vitreous space are recognized, and before orientation is easy.

Technique of Vitreous Examination

This is the appropriate time to detail the manner in which an examination of the vitreous should be done. It is presupposed that a careful gross examination of the anterior segment of the eye has been made with focal illumination. The pupil should be maximally dilated. Then, after the retina has been examined ophthalmoscopically, the vitreous should be studied, layer on layer, with plus lenses in the ophthalmoscope. In this way certain definite findings may be recorded,

Fig. 4 (Pischel). Goldmann slitlamp, showing Goldmann prism mounted on end of slitlamp arm and preset lens (Hruby lens) attached to headrest stand.

such as vitreous dust, fine fibrillar opacities, or larger discrete opacities. Next the slitlamp examination should be undertaken.

The slitlamp must be in a room which can be made completely dark. While absolute darkness is not necessary in all cases, in the more difficult ones, any extraneous light is a serious handicap.

With the patient seated with head comfortably in the head rest, the Hruby or preset lens is placed before the eye to be examined. The preset lens should be turned so that it is at approximately right angles to the axis of sight of the microscope. This avoids most of the reflexes, but further minor turnings of the lens will have to be made, to obviate all reflexes possible.

The Goldmann prism or similar device is next swung into place on the slitlamp arm (figs. 4 and 5). If a new Zeiss slitlamp is being used, the lamp arm is merely swung in closer, to within 15 or 20 degrees of the microscope axis but no closer.

It is a mistake to have the axis of the light beam and the axis of the microscope coincide. If this is done one is using the same system of illumination as in a binocular giant ophthalmoscope, except that one has a slitbeam for illumination instead of a round beam. In so doing one loses all the advantages of slitlamp biomicroscopy.

In slitlamp examination one is examining a very thin optical section. To be able to do so, one must look at this section from an angle so as to see its proximal surface, and not look at it from directly in front where all one would see clearly of the corneal section would be its anterior edge. This would be the same as strong focal illumination with a slit, and would not give any of the advantages found in slitlamp biomicroscopy.

Therefore, devices which attach between the objective of the microscope, to deflect the slitlamp beam into the fundus, do not enable one to examine the vitreous as is done with a slitlamp.

Continuing with the description of the slitlamp technique, it must be pointed out that with the lamp now set at the proper angle, one must observe to see if the slit and microscope are focused on the same plane.

In putting the Goldmann prism or similar device in place on the slitlamp arm, the focal point of the light beam is moved closer to the lamp. The microscope must therefore be refocused. It is easy to do this on the lens or iris, or better still the retina. First a moderately wide beam is focused accurately on the anterior lens capsule, for example, and then the microscope is carefully refocused onto the slitimage on the lens capsule.

One is now ready to proceed with the examination of the vitreous. I have found it advantageous to focus at once on the retina. Here one can finally check the "co-focus" of the slitlamp beam and microscope. Then by

Fig. 5 (Pischel). Examining vitreous cavity with Goldmann slitlamp.

slowly moving the focusing hand lever backward and forward, and slowly from side to side, one can easily examine the whole depth of the vitreous. The patient can be asked to fix on a fixation light, or sometimes better he can be directed to gaze in different directions, as directed, so that a large part of the vitreous can be explored.

In examining the region of the posterior pole and the vitreous in the region of the optical axis, binocular examination is easily possible. This gives a very graphic picture of the retina or of the vitreous, with stereoscopic depth perception giving a wonderful three dimensional picture of what is observed.

As the patient looks further to the right or left, the width of the pupil through which one is looking becomes narrower, and before the equator is reached, the pupillary aperture is so narrow that only monocular observation is possible. Usually one can readily sense when this occurs, even without closing one eye to test one's own binocular vision. When the patient looks up or down, this limitation does not occur until the most extreme rotation.

Binocular observation is obviously better than monocular and the observer should endeavor to use it whenever possible.

To observe still further in the periphery, the prismatic action of the strong preset lens can be brought into play. By looking through the edge of the lens, strong prism action base-in, out, up, or down can be obtained, and it is possible to look, monocularly to be sure, very far into the periphery of the fundus. One can probably see as far this way, as in direct ophthalmoscopy.

With the preset glass alone, the retina is seen in approximately life size. The microscope then will give different magnifications. For clinical examinations the lowest magnifications (about 10 times) are sufficient and most practical. For finer details magnification up to 20 times is practical. Higher magnifications, while possible, are technically very difficult and unsatisfactory.

Hruby lens and contact glass

This is a good time to discuss very briefly the advantages and disadvantages of the preset or Hruby lens, and the contact glass. The preset lens is obviously simpler to use, does not trouble the patient, and consumes no time for its insertion. It also allows a very much greater area of the fundus to be examined. The size of the field observed at one time is definitely smaller than with the contact glass, but in my opinion this is of little consequence. A definite disadvantage is that the image size is definitely smaller also, and for fine examinations of the macular region this, in my hands, has been a definite disadvantage.

The advantage of the contact glass is its greater field, and larger image, with less disturbing reflexes. The obvious disadvantages are the smaller area of fundus observable with this glass, and of less importance, the time and effort needed to insert it. This latter is truly of little importance with a good team of doctor and nurse to insert it, and with the capable nurse to help hold the glass in place. I regularly use it for careful examinations of the macula or in questionable findings in the vitreous. The greater magnification and clarity it gives is of greatest help.

Cases of very high myopia give difficulty with either lens. Usually they can be observed by means of an additional minus lens held before the other lens to increase its power.

Hazy media make observation very difficult. Maculas of the cornea can be very disturbing. Lens opacities, except for moderate nuclear sclerosis, are disturbing and if at all dense or irregular, make accurate observation of the vitreous impossible.

A maximally dilated pupil is needed for examining the greatest part of the vitreous cavity. The macula region can be observed with a partially dilated pupil, but little can be seen with a small active pupil.

Often examination of the vitreous can be advantageously started without the preset lens or contact glass. When the angle be-

tween the light beam and microscope has been reduced to 17 degrees or less (by means of the Goldmann prism, or proper adjustment of the lamp in the Zeiss instrument) one can see surprisingly far back into the vitreous cavity, sometimes three fourths of the way to the retina even in phakic eyes.

In this examination one will often find a surprisingly clear, and apparently optically empty space, of very shallow depth, just behind the lens. Considerable speculation still is being made as to the exact structures visible here. One of these is the membrana hyaloidea plicata, a very fine membrane whose true function is not agreed upon by all, and another the anterior hyaloid membrane. Here also the various types of rests of the hyaloid artery, known to all, can be seen attached to the posterior surface of the lens.

Occasionally an anterior detachment of the vitreous can be made out. This is most frequently seen in older patients. Here the vitreous may be detached, or shrunken back so that a definite grayish membrane, representing the anterior face of the vitreous can be seen. This may be entirely free of the lens, or only pulled free in the lower, or upper half of this area.

Focusing more deeply into the normal vitreous, one can see the membranelike structures which have been observed for years. One feature of these is that, on motion of the eye, they will sway about most freely and often with large excursions. However, on rest of the eye they slowly return to their original positions. One can also see some very fine dot-like opacities, some grayish (perhaps wandering cells or leukocytes) or some tiny brown pigment dots (Samuels[11]).

Even without the preset lens, a marked detachment of the posterior vitreous can sometimes be made out in this anterior portion of the vitreous cavity. When visible this way, it is very easily seen, due to lack of minification of the image, and lack of reflexes. Those detachments most readily visible are the ones associated with marked collapse of the vitreous, where the posterior surface of the vitreous has come at least to the center of the vitreous cavity. A more exact description of this will be given later.

Further (and deeper) examination necessitates the use of the preset lens or the contact lens. Now the posterior portion of the vitreous can be examined.

Observations

The further posteriorly one looks, the less one sees. The membranelike structures seen more anteriorly disappear from sight so that this region seems optically empty. This possibly is due to the fact that lighting conditions here are poor so that details are difficult to make out.

In older patients, the supporting structure becomes plainer, although not as regularly placed. Optically empty spaces, surrounded by normal membrane or fibrillarlike structures, are seen. This probably represents a degeneration of the vitreous structure, with liquefaction of the normal gel-like vitreous, and disappearance of some of the supporting structures with thickening or opacification of the remaining parts.

These denser membranes or fibers can even be seen with the ophthalmoscope. However, just where normal senile changes end and pathologic findings start is not easy to determine.

After inflammations such as iridocyclitis, large numbers of grayish, star-shaped opacities, with fine streamers attached, will be found. In choroiditis the same holds true, but one also sees large accumulations of these, as almost macroscopic appearing opacities.

Hemorrhages may be massive enough to reach forward almost to the lens. They may appear as ribbonlike dark reddish brown masses, or actual clumps of coagulated blood, of bright red hue. In older patients, the vitreous is filled with innumerable fine reddish brown dots, sometimes seen between

the vitreous structure or floating about in a liquefied area.

We know that the normal vitreous fills the vitreous cavity, and is very firmly attached at the ora serrata. This area has frequently been called the base of the vitreous. The vitreous is also slightly adherent to the optic disc. Elsewhere, under normal conditions it merely lies in contact with the retina.

For convenience sake, the posterior surface of the vitreous, in this discussion, will be spoken of as the posterior face, or posterior hyaloid membrane. Whether this is a true membrane or a condensation of vitreous membranes, and so on, cannot be discussed here.

Detachment of vitreous

A frequent finding in older patients with otherwise normal eyes is that the whole vitreous has shrunken slightly so that the posterior face has pulled away from its contact with the retina (fig. 6). This is called a posterior detachment of the vitreous. Such a detachment can assume various forms. There frequently is a partial detachment near the posterior pole. We then have a new anatomic condition within the eye. From the lens backward, we now have in the vitreous cavity, the vitreous, the subvitreal space filled with the subvitreal fluid, and then the retina.

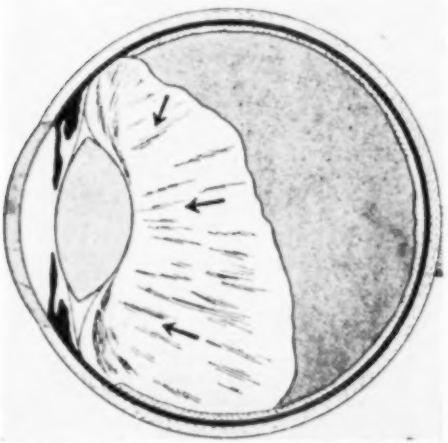

Fig. 6 (Pischel). Diagrammatic representation of a marked vitreous detachment (after Gonin).

Fig. 7 (Pischel). Schematic composite drawing of slitlamp view of marked detachment of the vitreous, light coming from left. Structures seen from left to right: Cornea, lens, vitreous, posterior vitreous face, retina (Rieger).

Is there any proof that this condition really exists, and is not a theoretical finding?

Von Sallmann[12] was able to demonstrate this condition in freshly enucleated eyes, which he carefully cut in half and then stained by the pyridine method.

Lindner,[13] Rieger,[14] and Samuels[11] also demonstrated this condition in histologic specimens, and, further, any man can look through his collection of pathologic specimens and, in the perfectly stained ones, can easily trace the posterior surface of a detached vitreous with an eosin-staining subvitreal fluid between it and the intact and properly placed retina. Thus the existence in vivo of a detached vitreous has been established.

This condition is illustrated by the accompanying diagram (fig. 7). It can often be seen quite clearly with the slitlamp.

The hyaloid membrane may show up as a quite homogenously gray surface, very slightly wrinkled or folded like wrinkled tissue paper. At other times the membrane may be so fine and transparent that it can only be seen with the greatest difficulty. As a

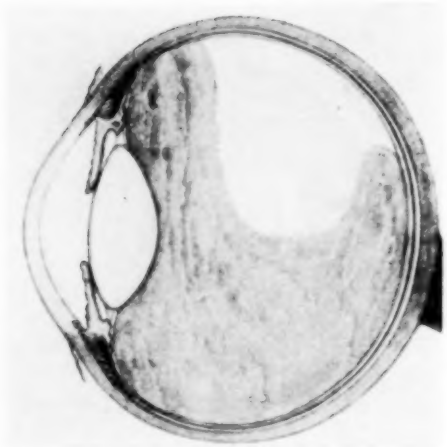

Fig. 8 (Pischel). Detachment of the vitreous with collapse in posterior superior quadrant (diagrammatic, Rieger).

matter of fact, it must be realized that while one can often definitely state that a vitreous detachment *is* present, one can never definitely state that it is ***not*** present.

In diagnosing the presence of a posterior vitreous detachment, one must be careful not to be deceived by the reflexes often seen in this examination. One reflex frequently seen is a thin perfectly straight line running absolutely vertically, with no deviation forward or backward. To be sure that one is seeing the vitreous face and not a reflex one must see it in more than just one place.

Often one can see the posterior membrane better temporally than nasally, or one will see it superiorly and not at all elsewhere, or any combination of these findings. At other times it can be readily traced over the whole posterior portion of the fundus.

The following is a help in the recognition of the posterior vitreous face by one who has not seen it before.

One should first focus on the retina, having beam and microscope sharply focused at this point. Then, with the light coming say from the left, one knows the beam will be focused on the hyaloid membrane to the left of where the beam strikes the retina. Therefore, as one gradually focuses more anteriorly, the membrane should appear to the left of the light patch on the retina, and to the right of the light beam in the lens (fig. 7).

Attention is again called to the fact, stated previously, that sometimes a marked vitreous detachment can be more easily seen using the slitlamp without the aid of the preset lens than with it.

Another type of vitreous detachment is the complete vitreous detachment, with the hyaloid membrane pulled away from the retina over almost its whole extent.

A limited detachment of the vitreous in the superior quadrant of the globe is also sometimes found (color plate, fig. a). Here, due to the higher specific gravity of the vitreous compared to the subvitreal fluid, the vitreous sags or collapses.

An inferior detachment of the vitreous is rare because, as already stated, the vitreous tends to sag downward. However, detachments inferiorly, and especially inferiorly and anteriorly, are sometimes seen after cataract extractions with loss of vitreous, but this does not qualify as a normal finding.

A much more frequent variation is a de-

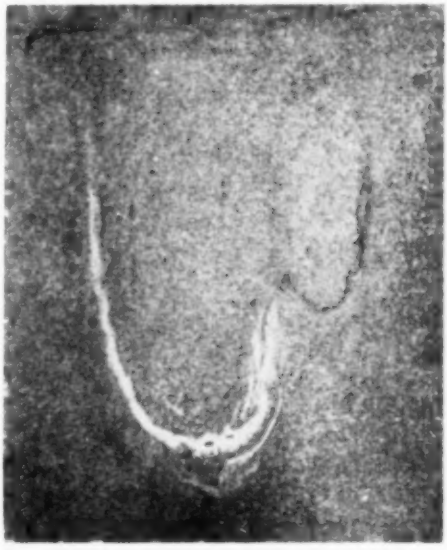

Fig. 9 (Pischel). Slitlamp view of Figure 8 when focused on anterior part of posterior vitreous face.

tachment of the vitreous with collapse in the posterior superior quadrant of the eye (figs. 8, 9, and 10; color plate, fig. b). This may be of slight extent so that it can only be seen if the patient looks far upward, and careful search is made with the preset lens. On the other hand, it may be so marked that the posterior surface of the vitreous is a short distance behind the lens, and it does not level off and run posteriorly until well below horizontal.

This detachment of the vitreous with collapse is the most easily seen of all these vitreous changes, and perhaps the most interesting (this is the type that can be readily seen without any preset or contact lens). When one examines such an eye with the slitlamp the posterior face of the vitreous can be seen to undulate like a jelly-fish in water, due to the movements of the eye. If the patient holds his eye perfectly still, the vitreous will assume again the same position seen originally.

As mentioned before, the vitreous is somewhat adherent to the optic disc. When the vitreous shrinks, it gradually pulls free from the disc. When the posterior face of the vitreous is free of its attachment to the disc it almost always shows some form of annular opacity in its posterior membrane (fig. 11).

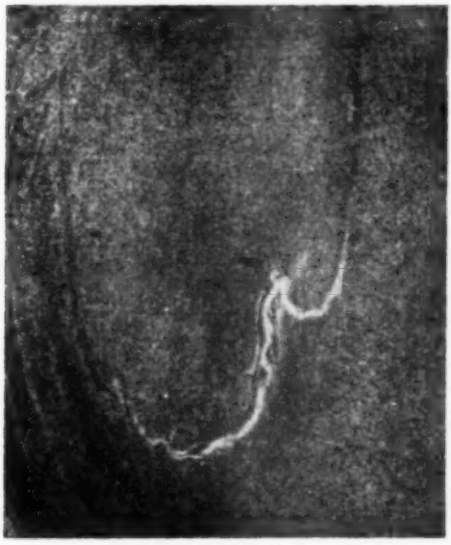

Fig. 10 (Pischel). Slitlamp view of Figure 8 when focused on posterior part of posterior face (Rieger).

Fig. 11 (Pischel). Annular opacity on posterior vitreous face (Hruby).

This may have a definite ring shape, often visible with the ophthalmoscope. It may be just in front of the disc, or slightly to one side. In cases of detachment with collapse it may be seen lying on edge. With time it may break, so that it will be an incomplete circle, perhaps in the shape of the letter J. This annular opacity is really a hole in the posterior membrane (color plate, figs. c and d). Hruby has described slitlamp observations in a case of a very definite ring opacity, where the liquefied vitreous could be traced as it poured out through the ring to become almost dissolved in the subvitreal fluid (color plate, fig. e).

Other holes in the posterior hyaloid membrane in locations far removed from the optic disc have also been described. And sometimes several holes close together but of different size have been reported.

Besides annular opacities, a number of irregular-shaped opacities, some multi-ocular, others "solid" but irregularly shaped, may be found on the posterior surface of the vitreous. Some of these are variations of the previously mentioned annular opacity. Some are denser discrete opacities (fig. 12), per-

Fig. 12 (Pischel). Discrete opacities seen on posterior vitreous face of detached vitreous (Hruby).

haps of glial tissue (Rieger[14]) which were pulled loose from the retina or disc by the shrinking vitreous (Simpson[15]).

When a vitreous detachment develops, it is often accompanied by certain symptoms. Patients will state that they have seen flashes of light, or sparks, or wavy bright lines (Moore,[16] Verhoeff[17]). Sometimes they complain of metamorphopsia. These symptoms usually last only a matter of hours, or at most a few days. These complaints are undoubtedly due to the traction on the retina of the detaching vitreous as it pulls loose from its former close contact with the retina (color plate, fig. f). They disappear when there is no further progress of the detachment.

These symptoms may then be followed by the complaint of the sudden appearance of an opacity before the eye. This may be a ring-shaped opacity, a J-shaped opacity, a curved line, a definite spot, or a round or comma-shaped opacity. These opacities assume many varied shapes. The appearance of these opacities may be the first complaint a patient has, with no preceding flashes of light as already described.

When patients with these complaints are examined carefully, 90 percent of them will show some definite form of vitreous detachment. The train of their symptoms is then easily explained, and they can be reassured that, if no other symptoms appear, they have nothing about which to be alarmed.

In all cases, vitreous detachment does not, however, cause these symptoms, or they are unnoticed by the patient. Why this is so, cannot be definitely explained. Perhaps, if the detachment of the vitreous develops very slowly over a period of months, the symptoms are so slight as not to be noticeable.

Again, in many normal eyes the attachment between vitreous and retina may be so tenuous that no definite traction is exerted on the retina as the vitreous retracts. And certainly many individuals are so unobservant that they do not notice or remember symptoms unless these are called to their attention.

There are, therefore, a large number of patients, with no complaints except those referable to the need for different glasses, who will show a detachment of the vitreous.

How frequently it is found in otherwise normal eyes cannot be definitely stated as yet. Like many other findings, the percentage of positive observations increases with the enthusiasm of the observer. It is known that myopic eyes are more prone to vitreous detachments, especially as years and degree of myopia increase. It is also known that eyes that have suffered from some intraocular inflammation, such as iridocyclitis or choroiditis, frequently develop this condition. But no good statistics are available for so-called normal patients.

Incidence in "normal" eyes

To obtain some idea of the frequency of this finding, I compiled the findings on 200 consecutive cases of new patients who came in for a routine refraction. None were included who came complaining of a spot or circle or line floating before the eye. This was done to prevent the "loading" of the statistics. While the number is very small, it still is a start on the problem, and it is planned to obtain findings on many more for a future study.

Of these 200 patients, 38 percent had a definite detachment of the vitreous demonstrable with the preset lens. Undoubtedly several more would have been found with the contact glass, so this figure is a conservative one. The ages of the patients ran from nine to 84 years.

Of the patients aged 50 years or over, 58

percent had a vitreous detachment. This condition was bilateral in 84 percent. Of these cases the type of vitreous detachment was similar in both eyes in 81 percent. These two latter figures of 84 percent for bilateral and 81 percent for similarity are quite striking. This might be interpreted as pointing to some rather general cause for this type of vitreous detachment, rather than some local disturbance in one part of an eye.

Due to limitation of space, many other interesting findings, most of which are pathologic in nature, cannot be taken up. In passing, however, mention should be made of the condition in which a detached vitreous can be seen to be attached to some retinal focus by a tonguelike extension. This is seen in those rare cases of horseshoe tears in the retina, without accompanying retinal detachment.

There are also occasional cases in which an operculum has been pulled out of the attached retina. This is seen ophthalmoscopically as a dark, round, or oval, or irregular opacity floating in front of the retina somewhere in the vitreous (Boeck[18]). With the slitlamp, this bit of tissue can be readily seen to be attached to the posterior vitreous surface, and from its position the hole in the retina can be found and the proper diagnosis of the condition can be made.

Parenthetically, in retinal detachments, the tear can often be visualized by this slitlamp technique, and the posterior hyaloid membrane can be seen adherent to its lip (color plate, fig. g).

It is worth brief mention that I have found a vitreous detachment in over 90 percent of all cases of simple retinal detachment.

Finally, although outside the sphere of the vitreous, the so-called "hole" in the macula should be mentioned. The diagnosis of this well-known clinical picture is often easily made with the ophthalmoscope. But in this way it is not always possible absolutely to rule out a small cyst. However, with resort to the slitlamp microscope, the presence or absence of a fine membrane makes the differential diagnosis of cyst or macular hole definitely possible (color plate, fig. h).

It is hoped this short presentation will stimulate further interest in the clinical examination of the vitreous by the practicing ophthalmologist.

490 Post Street (2).

I wish here to acknowledge the kindness and generosity of Dr. Karl Hruby, in permitting me access to a number of his unpublished illustrations of findings in the vitreous cavity and again to give credit to his book for many of the facts brought out in this paper.

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* A very complete bibliography is found in the book by Hruby.[8]

THE TREATMENT OF ABRADED CORNEAS OF RABBITS WITH CHLORESIUM OINTMENT AND TANTALUM-OXIDE POWDER

HELEN GRADY COLE, M.D., AND WENDELL L. HUGHES, M.D.
New York

In order to determine whether an abraded cornea heals more rapidly when treated with chloresium ointment,* tantalum-oxide powder, or with no treatment, experiments were performed on the corneas of rabbits and the results studied by gross examination and examination of tissue sections.

Chloresium ointment contains purified, highly concentrated, water-soluble derivatives of chlorophyll in a specially prepared, water-soluble ointment base for topical application. It is claimed that chloresium increases natural cellular activity.

Tantalum is an element that oxidizes as soon as it is exposed to air. Tantalum-oxide powder has been reported as relieving pain and promoting healing in severe burns.

One of us† began using tantalum-oxide powder and chloresium ointment in 1944 on the skin areas covered by dressings in eye plastic surgery cases, and it was decided to use these drugs in controlled experiments to determine their influence on the rate of healing of controlled corneal abrasions.

METHOD

Rabbits weighing approximately five pounds were selected for the experiments. Anesthesia consisted of 1.5 cc. of five-percent pentobarbital sodium in 10-percent alcohol administered intravenously and one drop of 0.5-percent pontocaine applied locally. In preparation for treatment the temporal one half of each cornea was curetted to remove the epithelium and the eyes were stained with fluorescein and irrigated with saline.

Ten groups of three rabbits each were treated as follows:

Rabbit 1: A glass spatula of chloresium ointment was applied to the right eye while the left was untreated.

Rabbit 2: The right eye was treated with tantalum powder from a shaker and the left eye was untreated.

Rabbit 3: A glass spatula of chloresium ointment was applied to the right eye and the tantalum powder to the left.

The eyelids were not sutured. The eyes were inspected six, 27, and 48 hours after the operation by staining with a drop of fluorescein followed by irrigation with normal saline. Treatment was repeated daily.

In previous experiments investigating the healing qualities of tantalum oxide and chloresium ointment, other methods of removing the corneal epithelium were tried by us. These consisted of attempts to peel off the epithelium, to remove the epithelial layer with a Graefe knife, and to dissolve the epithelium by application of 95-percent alcohol. The results of these experiments were unsatisfactory, probably owing to the fact that Bowman's membrane does not exist in rabbit's eyes and too much stroma was removed with the epithelium. The method finally selected of abrading the cornea with a small corneal curette was suggested by Hughes.

A complicating factor in experiments with rabbits is that the eyes, open during anesthesia, remain open through the recovery period, and during this period the cornea is subject to damage from straw or other foreign bodies that might be in the cage. During this period also, a rabbit may rub his eyes vigorously and repeatedly with his paws. Precautions, such as covering the floor of the cage with clean rags and perhaps immobilizing the rabbit in a harness should be taken to prevent such occurrences.

* The manufacturers of chloresium ointment advise against the use of chloresium ointment in the human eye as it is not sufficiently refined.

† Hughes, W. L.: Tantalum-oxide powder. Paper read before the American Society of Plastic and Reconstructive Surgery, New York, October 1, 1952.

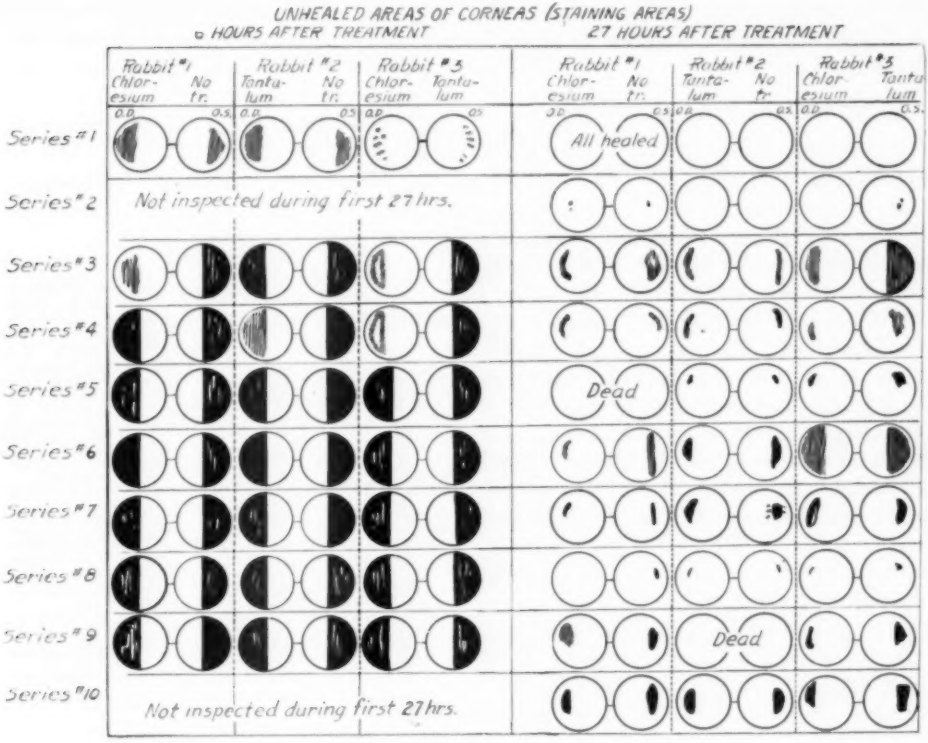

Fig. 1 (Cole and Hughes). Results of the experiments.

Results

The results of the experiments are shown in the accompanying chart (fig. 1) which compares the area of corneal staining (unhealed area) of the untreated eyes with the chloresium treated, untreated with tantalum treated, and tantalum treated with chloresium treated. In two series not shown in the chart, healing had occurred in all eyes when first examined after treatment.

An analysis of the results, shown in Table 1, indicates that chloresium is better than no treatment in 55 percent of cases, as good in 33 percent, and worse in 11 percent; is better than tantalum oxide in 70 percent of cases, as good in 20 percent and worse in 10

TABLE 1

Analysis of results

	Rabbit 1		Rabbit 2		Rabbit 3	
	O.D. Chloresium	O.S. Nontreated	O.D. Tantalum	O.S. Nontreated	O.D. Chloresium	O.S. Tantalum
Faster Healing	5 cases 55%	1 case 11%	1 case 11%	3 cases 33%	7 cases 70%	1 case 10%
Equal Healing	3 cases 33%		5 cases 55%		2 cases 20%	

percent; tantalum is better than no treatment in 11 percent of cases, as good in 55 percent, worse in 33 percent.

Pathology report

Three eyes, one treated with chloresium, one treated with tantalum, one untreated, were enucleated 28 hours after abrasion and treatment. They were placed in Bouins' solution on cotton in order to protect the cornea, and studied by tissue section.

Sections of all three eyes (treated with (1) chloresium, (2) tantalum oxide powder, (3) untreated) showed epithelium growing in over the denuded area.

The new epithelium decreases in thickness from seven to eight layers at the uninjured region of the epithelium to one cell thickness at the advancing margin. The new epithelium was normal in all sections and was less firmly attached to the underlying stroma than was the normal epithelium.

The chloresium sections appeared to have progressed further over the denuded areas than the "no treatment" or "tantalum treated" sections. Two sections of the "no treatment" globe showed central islands of new epithelium. There are two possibilities for the presence of these islands, one is that the surrounding epithelium was lost by artefact and the other that a few epithelial cells had survived the curettage.

Tissue sections were made in the laboratory of New York Eye and Ear Infirmary.

Conclusion

These experiments suggest that chloresium ointment is an aid to healing in the majority of cases, and is better for treatment of an abraded cornea than tantalum-oxide powder, which appears to be of little value. No irritation of the eye was produced by placing the powder in contact with its epithelial surface. However, sufficient tests have not been performed, and in order to draw a definite conclusion the experiment should be continued further.

375 Park Avenue (22).

Acknowledgement: Tantalum oxide supplied through the courtesy of Mr. Herbert Davis of the Ethicon Suture Laboratories, New Brunswick, New Jersey.

Ophthalmic Miniature

When we consider . . . how intimate the connection of the mouth is with the whole system, I am disposed to believe they (diseased teeth) are often the unsuspected causes of general, and particularly of nervous diseases. . . . I can not help thinking that our success in the treatment of all chronic diseases would be very much promoted, by directing our inquiries into the state of the teeth in sick people, and by advising their extraction in every case in which they are decayed. It is not necessary that they should be attended with pain, in order to produce disease.

Benjamin Rush,
Medical Inquiries and Observations, 3rd Ed., 1309.

OXYGEN STUDIES IN RETROLENTAL FIBROPLASIA*

II. The production of the microscopic changes of retrolental fibroplasia in experimental animals

Arnall Patz, M.D.
Baltimore, Maryland

Ann Eastham, Don H. Higginbotham, M.S., and Thomas Kleh, M.D.
Washington, D.C.

Introduction

In a nonrandomized study conducted in the premature nursery of the Gallinger Municipal Hospital between July, 1948, and January, 1951, a striking correlation between duration of oxygen therapy and incidence of both mild and severe retrolental fibroplasia was noted.[1]

To evaluate critically the role of oxygen therapy, a controlled randomized study was instituted in January, 1951. The results of this controlled nursery study[2] conducted between January, 1951, and May, 1953, supported the previous observations and justified the conclusion that prolonged high oxygen administration is an important factor in the development of retrolental fibroplasia.

Paralleling the nursery study begun in January, 1951, an extensive investigation was started to evaluate both the ocular and systemic effect of oxygen on several species of animals. The data and results of these animal studies are presented as separate experiments.

Experiment I

The effect of 70-percent oxygen concentrations on the immature opossum

Subjects and Methods

Wild pregnant opossums were trapped in South Carolina and shipped to the Patuxent Wildlife Research Refuge in Laurel, Maryland. Immediately after delivery or within 24 hours these mother animals with the young opossum in pouch were placed in oxygen chambers at 70-percent oxygen concentrations. The animals were kept continuously at these oxygen levels for 72 hours at which time the oxygen was turned off for 36 hours. The oxygen was again started for a period of 72 hours. Mother animals with their young in pouch were placed simultaneously in similar chambers at normal room oxygen (20.8 percent) to serve as controls.

Results

The mother animals showed a very marked susceptibility to the oxygen and invariably developed pulmonary edema and bronchopneumonia after four days in 70-percent oxygen. Due to the effect of oxygen on the mother animals it could not be determined whether or not any secondary effect that may have developed in the young animals might have resulted from abnormal maternal lactation. For this reason the study was discontinued.

Sixty-nine opossum young (eight litters) were studied who had received from three to five days' exposure to 70-percent oxygen. Fifty-one young opossum (seven litters) raised in room atmosphere served as controls. There were no significant differences between the eyes and other organs of the oxygen-treated young animals and their controls.

Experiment II

The in utero effect of maternal administration of oxygen on the developing rat fetus

A. Subjects and Methods

White rats were mated and a vaginal smear was performed daily. On the day that

*From the Department of Ophthalmology, Gallinger Municipal Hospital, Washington, D.C. This study was aided by grants from the National Institutes of Neurological Diseases and Blindness (B-102) and the District of Columbia Society for the Prevention of Blindness. Read in part before the Pediatric staff meeting, Gallinger Municipal Hospital, July 8, 1953, and the American Academy of Pediatrics, Miami, Florida, October 9, 1953.

the first positive sperm smear was detected the animals were separated. About the 12th day after a positive smear, if the animals were pregnant, a positive placental sign as indicated by a bloody vaginal plug was noted. This confirmed the 12th day of gestation.

The pregnant animals were then placed in a 90-percent oxygen environment at varying stages of pregnancy. Six mother animals were placed in the chamber on the 14th day of gestation, 16th day, 18th day, and six animals on the 20th day of pregnancy. Each mother animal was kept in oxygen at 90-percent concentration for 48 hours and then removed to room oxygen for a period varying from two to five days. The fetuses were obtained at the death of the mothers or, for the 20th gestational-day animals, were obtained during the first or third day after birth. Control mother animals of the same strain were placed simultaneously in room oxygen to serve as controls.

Results

There were no significant differences in the eyes and other organs of 86 oxygen-treated fetuses and 80 control animals. In one litter of oxygen-treated animals who received oxygen in utero from the 16th to 18th day of gestation, cataracts were detected in four animals. These were interpreted as a chance variation and unrelated to oxygen.

B. Subjects and Methods

Pregnant mother rats, raised in the same manner as in Experiment II-A were placed in a pressure chamber on the 14th, 16th, 18th, and 20th day of gestation. Six pregnant mother animals for each of these days of gestation were placed in the chamber at two-atmospheres positive pressure of pure oxygen (200-percent oxygen tension). The mother animals were kept in the chamber for six hours; the oxygen pressure was gradually reduced over 30 minutes before placing the animals in room oxygen. Each fetus or young animal was examined two days after oxygen exposure. Control animals were raised at room atmosphere.

Results

There were no significant changes detected in the eyes or other organs of 79 oxygen-treated animals when compared with control animals.

Experiment III

The effects of continuous oxygen at 80-percent concentrations on newborn rats

Subjects and Methods

Newborn litters of white rats were placed in the oxygen chamber at birth or within the first 18 hours of life. Newborn litters raised simultaneously at room atmosphere served as controls. For each litter receiving oxygen (80 percent), a control litter in room atmosphere (20.8 percent) was designated as its counterpart.

At 24- or 48-hour intervals, the oxygen-treated mother animals were exchanged with those in room oxygen so that each mother animal was exposed only 24 or 48 hours to the oxygen; a rest period of the same duration in room atmosphere then followed. This eliminated any oxygen toxicity effect on the susceptible mother animals. This also permitted the young animals to receive continuous oxygen therapy (simulating nursery administration). Of importance is that this insured practically identical nutritional factors from maternal lactation in the oxygen-treated and control young animals.

For one group of animals at the start of the experiment, the young were divided between the two mothers so that each mother animal was assigned half her own litter and half of her counterpart's litter. This provided litter mates as controls.

The control and oxygen-treated young animals were killed at 21 days of age and a complete autopsy was performed. The mother animals were examined in a like manner.

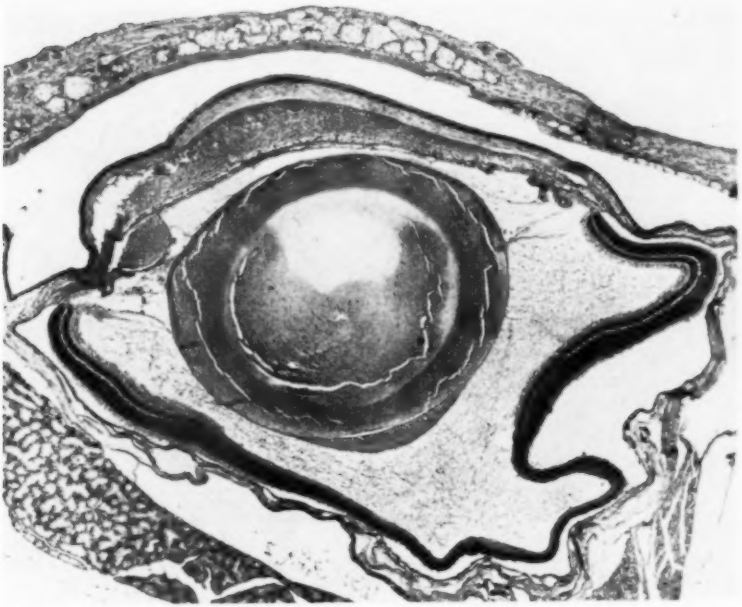

Fig. 1A (Patz, et al.). Section from eye of a 21-day-old mouse in continuous oxygen since birth. Note the massive anterior-chamber hemorrhage, hemorrhage in the iris stroma, and postlental hemorrhage. The vitreous is disorganized and takes on an irregular fibrillar pattern. (×40. Hematoxylin-eosin stain. Animal MP-26.)

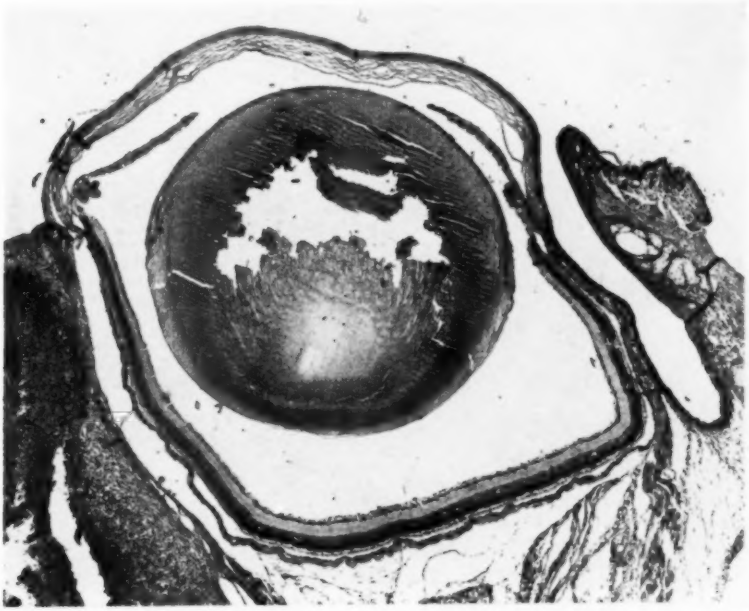

Fig. 1B (Patz, et al.). Litter-mate control to animal in Figure 1A; 21 days in room atmosphere. Note clear, homogeneous pattern of vitreous and absence of hemorrhage. (×40. Hematoxylin-eosin. Animal MP-26-C.)

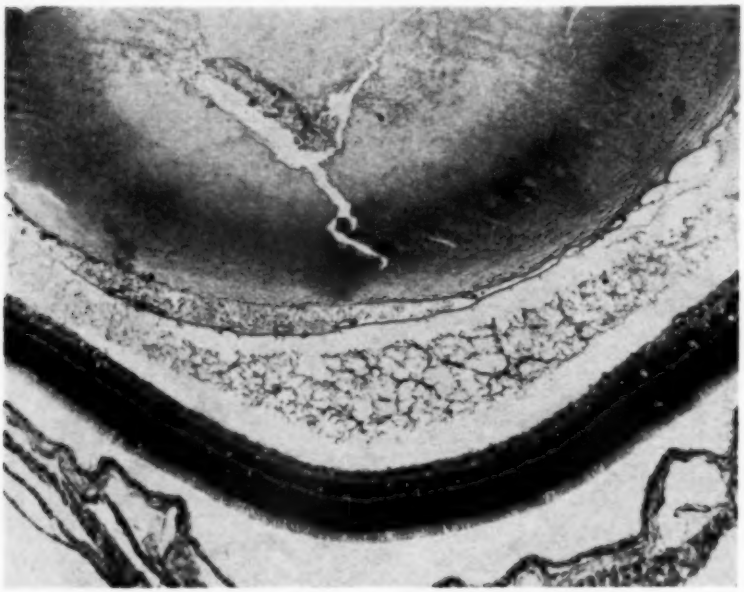

Fig. 2A (Patz, et al.). Section from eye of a 21-day-old mouse in continuous oxygen since birth. Note postlenticular hemorrhage, persistence of the capillaries of the tunica vasculosa lentis, and disorganization of the vitreous. (×100. Hematoxylin-eosin stain. Animal MP-35.)

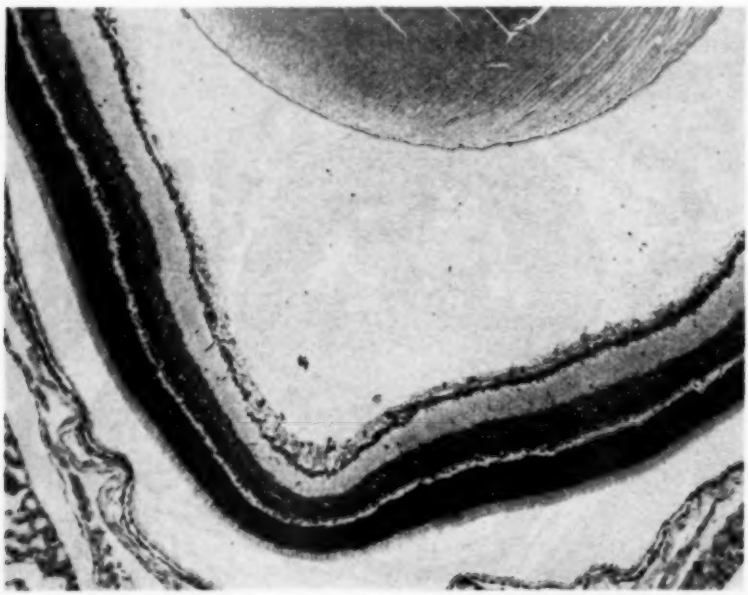

Fig. 2B (Patz, et al.). Litter-mate control to animal in Figure 2A; 21 days in room oxygen. Note normal vitreous and absence of hemorrhage and vessels of the tunica vasculosa lentis. (×100. Hematoxylin-eosin stain. Animal MP-35-C.)

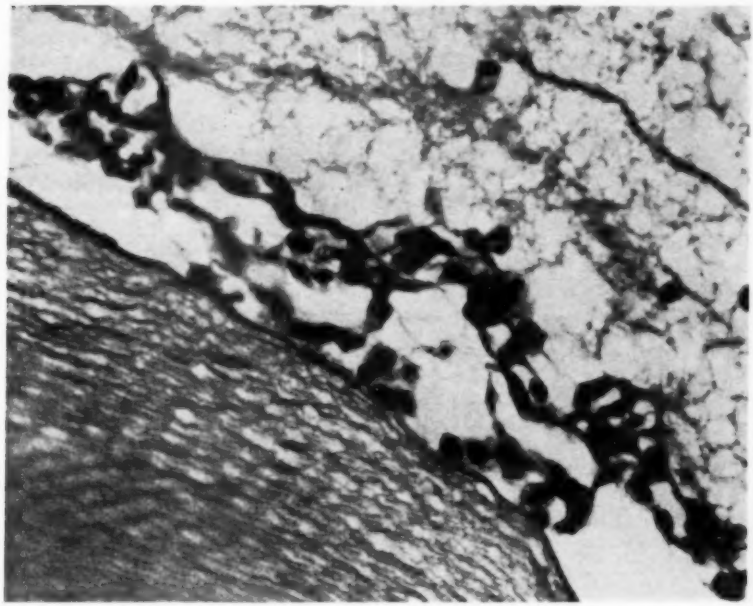

Fig. 3A (Patz, et al.). Section from the eye of a 21-day-old mouse in continuous oxygen since birth. Note the persistence and proliferation of capillaries of the tunica vasculosa lentis and the irregular bands in the vitreous. (×500. Hematoxylin-eosin stain. Animal MP-36-A.)

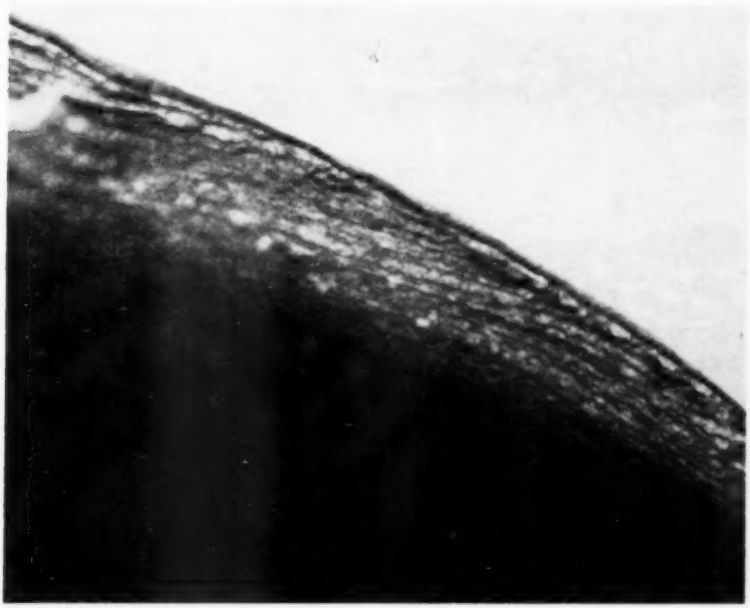

Fig. 3B (Patz, et al.). Litter-mate control to animal in Figure 3A; 21 days in room oxygen. Note absence of capillaries about the lens and normal vitreous. (×500. Hematoxylin-eosin stain. Animal MP-36-A-C.)

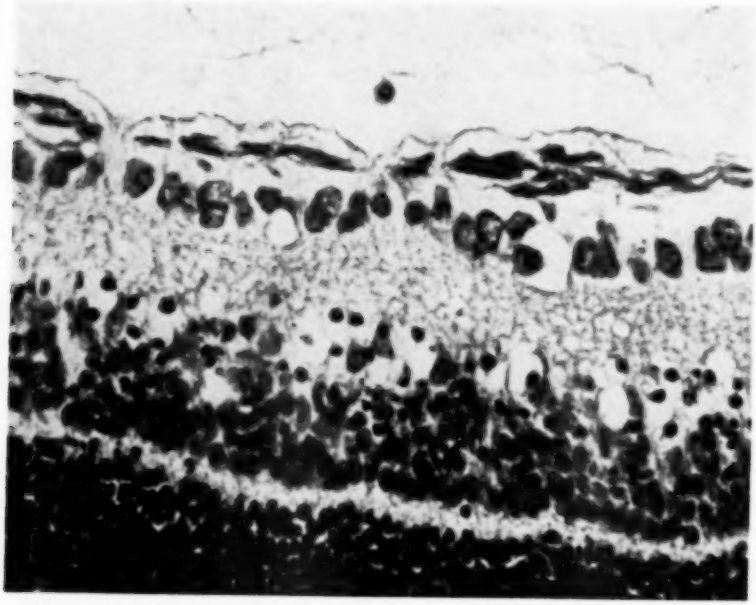

Fig. 4A (Patz, et al.). A section of an eye from a 21-day-old mouse in continuous oxygen since birth. Note the early proliferation of endothelial cells in the nerve-fiber layer of the retina and edema of the inner nuclear and plexiform layers. (×500. Hematoxylin-eosin stain. Animal MP-36-B.)

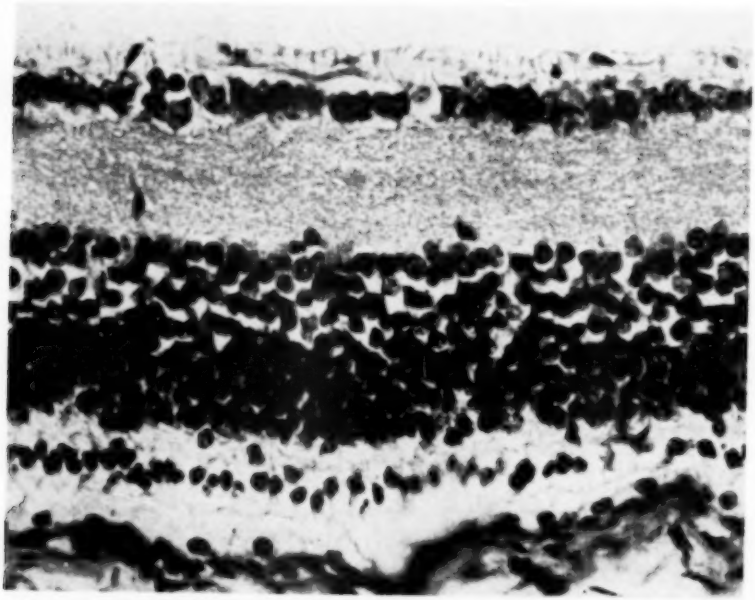

Fig. 4B (Patz, et al.). Litter-mate control to animal in Figure 4A; 21 days in room oxygen. Note relatively acellular character of the nerve-fiber layer and normal architecture of the other layers of the retina. (×500. Hematoxylin-eosin stain. Animal MP-36-B-C.)

Results

Forty-nine oxygen-treated young animals and 46 control young entered the experiment. The mother animals ate 22 young in oxygen and 17 young controls were lost. (Exchanging of mother animals was thought to have increased cannibalism.) Twenty-seven oxygen-treated young and 29 control young rats survived to 21 days of age and presented the following findings at autopsy:

Twelve of the 27 oxygen-treated animals showed ocular lesions in 17 eyes. The lesions consisted of persistence and proliferation of capillaries of the tunica vasculosa lentis and disorganization of the vitreous in all 17 abnormal eyes. Six of these 17 eyes showed prominent edema in the inner layers of the retina. In 58 eyes from 29 control animals none of these changes were detected.

Lesions were limited to the eyes in the oxygen-treated animals. An examination of brain, heart, lungs, liver, pancreas, spleen, and adrenals showed no difference between control and treated animals. Autopsies on the mother animals showed no abnormalities. Particular attention was given to the lungs of the mother animals for possible oxygen toxicity changes.

Experiment IV

The ocular and systemic effects produced by raising newborn mice in continuous oxygen at 80-percent concentrations

Subjects and Methods

Newborn litters of white mice were placed in the oxygen chamber at birth or within the first 18 hours of life in the same manner as described in Experiment III. Control animals were likewise raised and exchanged as in Experiment III. Of 122 newborn animals raised in oxygen, 108 survived to 21 days of age; of 126 controls, 107 survived.

The oxygen-treated animals were divided into three groups. One group received continuous oxygen for seven days, one group 14 days, and one group 21 days. All oxygen-treated mice and control animals were killed at 21 days of age. Histologic examinations were made of the brain, eyes, lungs, heart, liver, adrenals, kidneys, and spleen. An autopsy was also performed on each mother animal.

Results

There was a definite correlation between the induced ocular lesions and the number

TABLE 1

Showing incidence of ocular lesions in oxygen-treated and control mice

(All treated animals received 80-percent oxygen continuously from birth for either 7, 14, or 21 days. Control animals were raised in room oxygen (20.8 percent). All animals were killed at 21 days of age.)

	Number of Animals	Number of Eyes	Normal Eyes	Abnormal Eyes	Ocular Lesions				
					Intraocular Hemorrhage	Abnormal Persistence and Proliferation of Tunica Vasculosa Lentis	Vitreous Changes	Retinal Edema	*Nodules of Endothelial or Glial Cells in the Retina
21 days oxygen	38	76	5	71	71	70	71	14	17
Controls	37	74	74	0	0	0	0	0	0
14 days oxygen	34	68	27	41	36	40	41	4	11
Controls	33	66	64	2	0	2	0	0	0
7 days oxygen	36	72	51	21	8	11	6	0	0
Controls	37	74	74	0	0	0	0	0	0

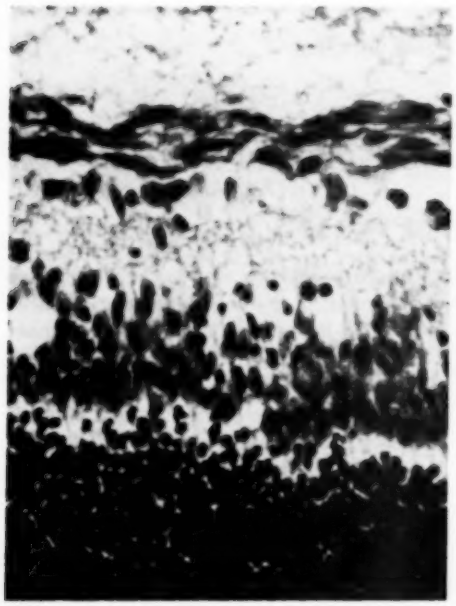

Fig. 5 (Patz, et al.). Section from eye of a 21-day-old mouse in continuous oxygen since birth. Note proliferation of endothelial and glial cells in the nerve-fiber layer of the retina and changes in the overlying vitreous. Note vacuolation of inner nuclear layer and edema of inner plexiform layer. (×500. Hematoxylin-eosin stain. Animal MP-38-A.)

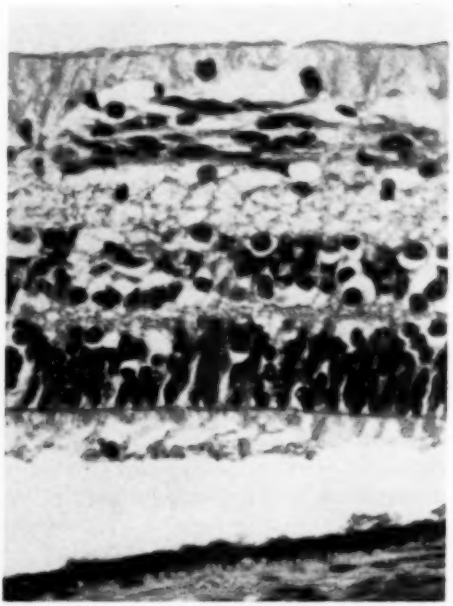

Fig. 6 (Patz, et al.) Section from eye of premature infant born at Gallinger Municipal Hospital, April, 1951; died at age of 49 days, with early active retrolental fibroplasia diagnosed clinically. Note nodules of endothelial cell proliferation in nerve-fiber layer of retina and retinal edema. Note similarity of these changes with those in animal MP-38-A in Figure 5. (×500. Hematoxylin-eosin stain. Hospital No. 28467.)

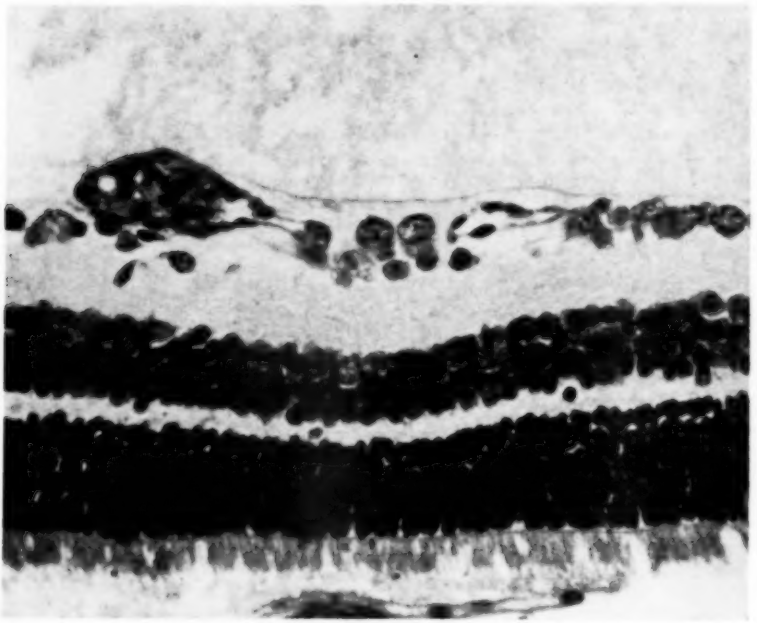

Fig. 7 (Patz, et al.). Section from eye of 21-day-old mouse in continuous oxygen since birth. Note proliferation of endothelial cells in nerve-fiber layer and budding of capillary into vitreous. (×500. Hematoxylin-eosin stain. Animal MP-41-A.)

of days' exposure to oxygen. These ocular lesions consisted of hemorrhage, persistence and proliferation of capillaries of the tunica vasculosa lentis, vitreous degeneration, retinal edema, and endothelial or glial cell nodules in the nerve-fiber layer of the retina. These lesions are tabulated in Table 1. Except for two animals in the control group that showed abnormal persistence of the tunica vasculosa lentis, the control animals showed none of these changes.

There were only occasional lesions in the other organs of the oxygen-treated animals as compared to the controls. Two oxygen-treated animals showed focal renal hemorrhages. One oxygen-treated animal showed complete atelectasis of one lung. One oxygen-treated animal showed hemorrhages in the brain. Four oxygen-treated animals showed marked vacuolization of the liver; fat stain (oil-red-O) demonstrated these to be due to fatty infiltration.

Discussion

When oxygen is administered for prolonged periods to nursing animals, many problems are presented by the susceptibility of the mother animals to oxygen poisoning. Typically, in about 72 hours after exposure of an adult animal to 80-percent oxygen, toxic symptoms appear as a result of pulmonary irritation. Pathologically, pulmonary edema, lung hemorrhages, and bronchopneumonia are commonly found.

In contrast, the newborn or young animals are resistant to the pulmonary irritating effects of oxygen. In our own experiments, young rats have been raised in 100-percent oxygen for as long as 22 days, continuously, with no pulmonary changes occurring. It has been suggested[3] that the resistance of the young animals to the pulmonary effects of oxygen is due to the increased cellularity of the alveolar epithelium.

At any rate, it becomes necessary, when nursing animals are to be exposed to oxygen for a prolonged period, to provide a way to protect the mother animal from oxygen toxicity. In Experiments III and IV, this was done by working simultaneously with the control animals and oxygen-treated animals. At either 24- or 48-hour intervals the mother animals of the oxygen-treated animals and their control partners at room atmosphere were exchanged. This protected the adult mother animal from oxygen toxicity. This method also provided a better control on nutritional factors, since the oxygen-treated offspring and control animals received approximately identical maternal lactation. In some of the experiments, the litters were divided between oxygen-treated and control mother animals to provide litter mates as controls.

The following ocular lesions produced in Experiments III and IV are strikingly similar to the changes detected in human retrolental fibroplasia.[4, 5, 6]

1. Proliferation of intraocular capillaries
2. Intraocular hemorrhage
3. Retinal edema
4. Disorganization of the vitreous
5. Nodules of endothelial cell proliferation in the nerve-fiber layer of the retina
6. Capillary proliferation from the retina into the vitreous
7. Limitation of oxygen-induced changes to the eyes

It is of interest to note that Gyllensten and Hellstrom[7] recently demonstrated similar ocular lesions in approximately one third of 50 mice raised in 100-percent oxygen intermittently. In their experiment, mother animals were protected from oxygen poisoning by administering oxygen for 48 hours then turning off oxygen for 24 hours. Since their paper appeared, we have administered oxygen intermittently to a small number of mice, according to their protocol. The findings conform to those described by Gyllensten and Hellstrom. In this experiment, however, one cannot rule out a nutritional factor due to the oxygen exposure altering maternal lactation. In Experiments III and IV, we attempted to control this factor by exchang-

ing mother animals of oxygen-treated and control litters instead of turning off oxygen.

In pilot studies on four litters of newborn kittens and two litters of newborn puppies raised in 70-percent oxygen, the ophthalmoscopic changes were retinal edema and hemorrhage, vitreous haze, and, in one animal, partial retinal detachment. Microscopically, these eyes reveal, in 100 percent of the animals, the characteristic endothelial nodules of retrolental fibroplasia in the retina, with budding of capillaries into the vitreous.

Experimental and clinical observations which offer clues to the possible mechanism of the oxygen effect have been discussed in detail in clinical reports.[1,2] Those data are briefly summarized here as follows:

1. Diminished retinal blood flow from vasoconstriction resulting in:
   a. Depletion of metabolites to the retina
   b. Retention of metabolic end-products in the retina
   c. Anoxia distal to constricted retinal arterioles, provided diffusion of oxygen from the choroid does not compensate
2. Inactivation of retinal sulfhydryl enzymes.

The human retina is not fully vascularized to the ora serrata until a fetal weight of approximately 2,000 gm. is attained. Consequently, a premature infant with a birth weight of 1,000 to 1,500 gm. has a considerable portion of the anterior retina devoid of its blood supply. While the infant is receiving oxygen therapy, an increase in oxygen tension in the choroid theoretically may permit diffusion of oxygen across the retina to increase to above normal the oxygen tension in the unvascularized retinal periphery. This increase in oxygen tension would probably inhibit the normal extension of vascularization toward the anterior retina and would further deplete the supply of blood-borne constituents to the anterior retina.

In infants and in laboratory animals exposed to prolonged oxygen administration, the marked vasospasm that has developed has been noted to persist for as long as three hours after removal from oxygen. During this period, the choroidal oxygen tension has dropped coincident with cessation of oxygen administration. Retinal anoxia distal to the constriction might result until normal retinal blood flow was re-established.

It is important to stress here that many animals were raised in continuous high oxygen levels until killed, and "rapid withdrawal" from oxygen did not enter the experiment. Secondly, in our nursery study, 12 cases of active advanced retrolental fibroplasia developed while the infants were receiving continuous high-oxygen therapy in the Isolette incubator.

Our present clinical and experimental data suggest strongly that high oxygen therapy alone may produce the changes of retrolental fibroplasia. It is reasonable to assume, however, that rapid withdrawal from prolonged oxygen therapy may further accentuate the injurious effect of high oxygen administration. The concept of "rapid withdrawal" was first suggested by Szewczyk.[8] A controlled experiment is in progress in our laboratory to determine whether or not "rapid withdrawal" accentuates the lesions induced by continuous oxygen administration.

The mechanisms of vasoconstriction and diminished retinal blood flow immediately suggest the possible therapeutic benefit from the use of vasodilators with oxygen therapy in the premature nursery. Studies are in progress to determine the effect of stellate-ganglion section and several vasodilator drugs. Studies are planned to determine if sulfhydryl compounds protect against the oxygen-induced changes in animals.

Conclusions and Recommendations

1. By exposing newborn rats, mice, kittens, and puppies to 70- to 80-percent oxygen concentration for varying periods of time, changes in the eyes closely resembling human retrolental fibroplasia have resulted. The characteristic endothelial nodule in the nerve-fiber layer of the retina, with budding of vessels through the internal limiting mem-

brane into the vitreous, and retinal hemorrhages have been produced. The mouse and the kitten proved to be the most satisfactory laboratory animals for this study.

2. The results[1,2] of a nonrandomized nursery study conducted from July, 1948, to December, 1950, and the results of a randomized study conducted from January, 1951, to May, 1953, in our premature nursery have implicated prolonged oxygen therapy as an important factor in the etiology of retrolental fibroplasia. The experimental production of the typical lesions of the human disease in four species of animals by the administration of oxygen gives strong support to the original hypothesis.

3. It seems justifiable from the clinical and experimental data to make the following recommendations:

a. A rigid curtailment of oxygen therapy, compatible with the physical status of the premature infant, be practiced in the nursery.
b. To insure this, an accurate oxygen analyzer should be standard equipment in every premature nursery.
c. Frequent samplings of oxygen tension should be taken when oxygen is administered.
d. Except for emergency use, oxygen therapy should require a specific order.
e. Oxygen should be ordered by concentration rather than by flow rate.

Summary

The ocular and systemic effects of oxygen in immature opossums, fetal rats, newborn rats, mice, kittens, and dogs are presented.

The clinical implications of these animal experiments are briefly discussed in light of a controlled nursery investigation of the role of oxygen administration in retrolental fibroplasia.

Appendix

The oxygen chambers used consisted of an outer chamber made of plexiglass (capacity 78 cubic liters) in which the individual animal cages were placed. U.S.P. medical oxygen was used exclusively in the entire experiment.

Precision flow meters were used which maintained a constant flow rate regardless of pressure and which permitted setting the flow rates accurately within one-fourth liter flow. Humidity was controlled at within 65 to 80 percent with a fine strainer-type humidifier bottle. Oxygen concentration in the chamber was measured at least once daily with a paramagnetic analyzer (accurate within two-percent concentration); this was standardized at room oxygen before each reading.

CO_2 analyses were done at irregular intervals during each experiment. A Haldane type gas analyzer using potassium hydroxide to absorb CO_2 was used. CO_2 readings usually ranged between 0.10 percent and 0.20 percent with a maximum reading of 0.40 percent CO_2 obtained in one chamber. No gas analyses were made until the chambers had been closed for one hour.

The temperature during the experiment ranged between 80° F. and 84° F. for most of the experiments. Temperature was recorded with a maximum-minimum temperature thermometer. All experiments with the exception of the opossum study were done in air-conditioned animal rooms maintained at about 80° F.

The animals were killed by exsanguination, and control and treated animals were always killed and processed simultaneously whenever possible. The eyes were placed in Bouin's solution for 24 hours then transferred to 10-percent formalin. All specimens were embedded in paraffin and sectioned six microns in thickness. The entire eye was cut on each specimen. Usually every other ribbon was discarded. Except for certain special stains, all sections were stained by hematoxylin and eosin.

Addendum

Since this paper was submitted for publication, Ashton and co-workers (Brit. J. Ophth., September, 1953) have demon-

strated similar lesions in kittens exposed for varying periods to oxygen at 70- to 80-percent concentration. The changes described in their carefully controlled experiments conform closely, if not identically, to the experimental lesions herein described. These supporting data from an independent experiment further strengthen the implications of the animal results in terms of premature nursery oxygen routine.

920 Saint Paul Street (2).

ACKNOWLEDGEMENTS

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OPHTHALMIC MINIATURE

Case 1. G. B., at 16, a cock and tap maker, first admitted January 12, 1880.

History:—For the last two years has been subject to epistaxis, usually from the left side of the nose.

Ophthalmoscopic Examination:

Left eye—A large irregular, roundish, partially decolorized hemorrhage, near fovea, and several smaller hemorrhages nearer periphery, a few striated. Vitreous full of opacities.

Henry Eales,

Birmingham Medical Review, **9** (new series **3**):262, 1880.

SURGERY OF CONGENITAL GLAUCOMA

Review of 196 eyes operated by goniotomy

Otto Barkan, M.D.
San Francisco, California

In previous articles the diagnosis, mode of action of goniotomy, and urgency of early operation in congenital glaucoma have been discussed.[1-5] In the present article the results of goniotomy performed on 196 eyes afflicted with congenital glaucoma are evaluated. Recent modifications in technique and additional observations on congenital glaucoma are presented. Since intraocular pressure and size and cloudiness of the cornea are important factors in the diagnosis and surgical treatment, these will be discussed before proceeding to the consideration of other aspects.

Intraocular pressure in the infant

Early in the series tensions were taken under open-drop ether anesthesia. Later the intratracheal method was used because complete reliability of readings could be more readily assured and because it was safer. A mixture of nitrous oxide, oxygen, and ether was used with the Leigh technique.[6] The lids were held off the eyeball with a speculum when necessary.

Readings taken in 20 normal eyes of infants between the ages of two months and two years showed that the average intraocular pressure at this age varied between 20 and 28 mm. Hg (Schiøtz). Normal fellow eyes in infants with unilateral congenital glaucoma gave similar readings.

Differences in corneal diameter in the range between 10 and 12 mm. did not appear to influence the tension. In eyes with corneal diameters of 13 mm. and over, however, one gained the impression that tonometric readings were relatively too low. It seems likely that the readings in distended eyes may be influenced by the flattening of the central area of the cornea, the greater indentability of the thinned cornea, decreased scleral rigidity, and by the fact that the amount of fluid displaced by the plunger has less effect on the reading of the tonometer as the total volume of the eyeball increases. Further investigation of this subject is required.

The relatively low pressure indicated by the tonometer in the markedly distended globe may be due not only to the factors mentioned above but it may also be actual and due to increased outflow, the result of stretching of the angle region, or to reduced function of the ciliary body.

Advisability of operation in distended eyes may depend on evaluation of the intraocular pressure in relation to other clinical findings. Clinically one gains the impression that whereas a tension of 28 mm. Hg (Schiøtz) may be well tolerated by an undistended eye for a considerable length of time, it is injurious to the more markedly distended buphthalmic eye which shows excavation of the optic nerve.

Corneal diameter and familial large eyes

When taking the intraocular pressure, complete relaxation is mandatory. This is best achieved under ether, preferably administered intratracheally. This was brought out by a number of eyes with large corneal diameters encountered in this series which had been erroneously diagnosed as congenital glaucoma and in which operation had been advised. The pressure had been taken under vinethene anesthesia or under open ether.

In one case, a child six months of age, the tension taken under open ether anesthesia had been reported increased. The corneas were 11.5 mm., measured with calipers in the horizontal diameter, and the palpebral fissures appeared wide. Tension taken under intratracheal ether anesthesia was normal (22 mm. Hg Schiøtz) on two occasions. The family history disclosed that the large size

of the father's eyes had been noticed when he was a boy.

In another case, a boy five years of age, the tension taken elsewhere under vinethene anesthesia was found increased and bilateral iridencleisis had been advised. Examination showed the corneal diameters to be 11.75 mm. The gonioscopic findings were normal. Tension taken under ether anesthesia was normal three times during the course of three weeks. Tension repeated annually in the following four years confirmed the diagnosis of physiologic conditions.

In another child, two years of age, tension had been reported increased and operation advised. Corneal diameters were: R.E., 15 mm.; L.E., 16 mm. Under complete relaxation with ether, tension was found to be 18 mm. Hg (Schiøtz). Gonioscopy with the microscope and slitlamp showed no signs of congenital glaucoma. Diagnosis of megalocornea was made.

It is important to recall physiologic and familial variations in corneal diameter when considering a diagnosis of congenital glaucoma. However, in infants with large eyes it is better to suspect congenital glaucoma than to overlook the possibility.

Irregular astigmatism

In congenital glaucoma the optic disc and fundus often appear blurred to direct ophthalmoscopic examination even though the cornea appears to be clear. If in these cases ophthalmoscopy is performed through the contact glass,[7] an exquisitely detailed picture of disc and fundus is obtained. The blurred image has been cleared by the contact glass. The explanation appears to be that irregular astigmatism which is the residue of previous corneal cloudiness caused the blurring of the image and that this astigmatism was eliminated by the contact glass.

By the same token the reduced visual acuity in these cases is presumably an amblyopia, acquired during the period of early cloudiness and its resultant irregular astigmatism.

A contact glass when applied to older children cleared the fundus picture for ophthalmoscopic examination but did not improve the patient's vision, evidently because the vision was reduced as the result of the amblyopia acquired in infancy. The macula and optic nerve appeared normal.

Visual results

Sufficient time has now elapsed to permit testing the visual acuity of many of the patients operated upon in this series. Reduction of visual acuity was caused in most cases by corneal scars, irregular astigmatism, ruptures of Descemet's membrane, or amblyopia the result of interruption of development of central vision during infancy. Ultimate visual acuity depends largely upon how soon after its onset the tension was normalized and the cloudiness relieved.

Corneal cloudiness occurred in most cases. Injury to the optic nerve occurred only in neglected cases in which normalization of tension was unduly delayed or was never achieved. In monolateral cases amblyopia was often the result of anisometropia or corneal scars. Amblyopia of one eye developed later in some cases as the result of neglected strabismus.

Pathologic findings in the angle

Method of examination

Gonioscopic studies were made with the patient under intratracheal anesthesia by means of a glass goniolens, hand slitlamp,[8] and binocular microscope mounted by universal joints on an adjustable and movable stand.[9] Total magnification was ×30 (fig. 1).

Pre-operative gonioscopic findings

In congenital glaucoma the angle presents a characteristic gonioscopic appearance. The iris lies in a horizontal plane. Instead of dipping backward to form the sinus of the chamber angle as in the normal eye, it continues horizontally or is pulled up toward the line of Schwalbe.

Between the line of Schwalbe and the at-

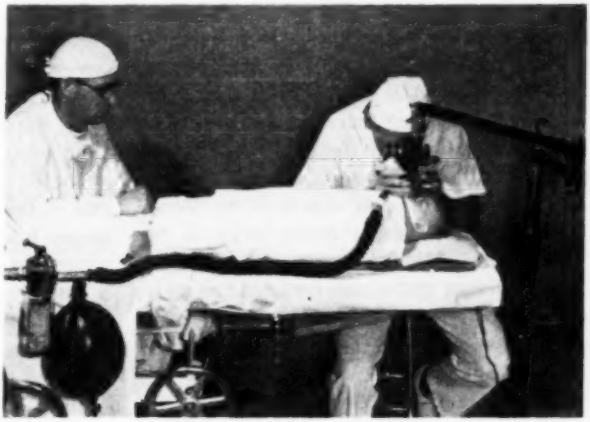

Fig. 1 (Otto Barkan). Examination of infant under intratracheal anesthesia with microgonioscope and hand slitlamp.

tachment of the anterior surface of the iris there is a membranous surface[9] which occupies an approximately vertical plane in contrast to the oblique plane of the normal angle wall. The surface exhibits a delicate stippling or shagreen. When examined with the microscope and illuminated obliquely or by transillumination with the hand slitlamp, the shagreen continues on to the stroma of the iris and partially covers the crypts. It is suggested that it represents the endothelium. I have not found a report of it in the literature.

The width of the vertical surface varies in different cases and in the same eye. It may be wide or so narrow that it barely constitutes a line, depending upon the distance of the insertion of the anterior stromal layer of the iris from the line of Schwalbe.

It is usually semitranslucent but shows variations from a rather strongly reflecting surface to a moderate translucency. There may be a few tendrils of uveal meshwork and occasionally a small blood vessel in it. When this cellophanelike surface or membrane has been removed or divided by goniotomy, some tendrils of uveal tissue may be seen crossing the space behind it; the true angle wall is seen in the depth.

In normal eyes of older brunette children remnants of light gray filaments and stumps of filaments can occasionally be recognized near the root of the iris. They stand out in contrast to the fully developed brown uveal meshwork and give the impression of being residues of embryonic tissue.

In blue irises in nonglaucomatous infants the peripheral portion of the pigment layer, arranged in radial segments, can be seen in a striking manner through the unpigmented thin stroma. In congenital glaucoma the distal portions of these pigment segments are drawn upward toward the line of Schwalbe. After goniotomy they drop back into a horizontal plane.[4,5] Various forms and gradations of these anomalies may be observed in different cases and in the same eye.

The impediment to outflow appears to consist in the changes described in the foregoing since division of the semitranslucent delicate membrane by goniotomy and recession of the root of the iris results in normalization of pressure. Postoperative gonioscopic observation of the incised area indicates that the space behind the membrane is, in part, optically empty and in part is traversed by delicate gray tissue elements (iris processes or persistent uveal meshwork?).

The gonioscopic appearance as described above conforms to what has been found in a study of histologic specimens of *early* cases of congenital glaucoma.[10-13] It suggests a persistence of embryonic conditions in the angle and in many cases an anterior insertion of the iris which appears to be the result of lack of differentiation. Collins suggested that there is imperfect separation of the iris from

the cornea at the periphery due to arrested development.

A blood-filled Schlemm's canal[3, 4] is frequently observed in infants with congenital glaucoma indicating that Schlemm's canal is present in most early cases. Because of the marked translucency of the angle wall in infants, the position in depth of the blood-filled Schlemm's canal could be made out with remarkable exactitude when using a hand slitlamp and corneal microscope. The blood-filled canal may be hidden by the iris in those cases in which the iris inserts close to the line of Schwalbe. When, in these cases, the iris is recessed by goniotomy the blood-filled canal is exposed to view.

An abnormally posterior position of Schlemm's canal has been reported in congenital glaucoma. It has been regarded as a factor in the impediment to outflow.[10] It may be that the posterior position of Schlemm's canal is only apparent in that the false anterior insertion of the iris makes Schlemm's canal appear to be situated relatively posteriorly. When the insertion is divided by goniotomy and the root of the iris drops backward the position of Schlemm's canal appears normal relative to other structures.

Since some mesoblastic tissue is normally present in the angle at birth, it is not always easy to distinguish gonioscopically between a normal and abnormal angle during the first years of life. However, if the gonioscopic findings are considered in relation to the history (corneal cloudiness, or congestive symptoms), to the diameter of the cornea at the given age, and if, in unilateral cases, a comparison is made with the fellow eye, it is almost always possible to make the correct diagnosis. If there is doubt miotics should be prescribed and the eye re-examined at intervals.

A fellow eye, even though of normal appearance and with normal tension, should be observed at regular intervals until adult life. I have observed the development of increased pressure in a fellow eye at the age of seven years.

In 1942, in a child nine months old, the pressure was: R.E., 20 mm. Hg; L.E., 43 mm. Hg (Schiøtz). The left eye had become cloudy four days previously. Corneal diameters were: R.E., 11 mm.; L.E., 13 mm. Goniotomy with the glass normalized tension in the left eye. The right eye appeared normal in every respect except that the gonioscopic findings were slightly suggestive of congenital glaucoma.

The eye was carefully observed in the ensuing years. The eyes were examined under ether anesthesia several times over a period of seven years.

In 1949, the tension in the right eye increased to 28 mm. Hg; in the next five weeks it increased to 46 mm. Hg. Excavation of the nervehead increased. The corneal diameter was unchanged. Goniotomy with the glass reduced the pressure to normal without the use of miotics.

Postoperative gonioscopic findings

Gonioscopy shows that as the result of goniotomy the root of the iris drops backward.The operated portion of the angle appears cleared of obstructing tissue and the true angle wall or trabeculum becomes exposed to aqueous.[5] If the incision is superficial enough, it results in a clean separation of the tissue from the underlying trabeculum without damage to it.

In many cases, the scleral spur can be identified in the stripped area. In several instances of successful normalization of tension, the blood-filled Schlemm's canal was plainly visible with its characteristic undulating outline adjacent and anterior to the spur indicating that the trabeculo-Schlemm's mechanism was undisturbed. It appears evident that injury to this mechanism should be avoided. This emphasizes the importance of stripping or teasing off the tissue superficially by operating under the glass whenever possible, that is, under gonioscopic control.

A successfully operated eye has not yet come to anatomic examination.

Results of goniotomy in 196 eyes

In this series a total of 196 eyes have been operated during a 17-year period; 188 have complete follow-ups—of these 152, or 80 percent, have maintained normal pressure without the use of miotics. All eyes except eight showed cloudiness of the cornea or had a history of cloudiness.

When first seen, over 100 cases showed very marked cloudiness. In 139 eyes the preoperative tension was between 45 mm. Hg and 100 mm. Hg (Schiøtz). In the remaining eyes the preoperative tensions were between 35 mm. Hg and 45 mm. Hg (Schiøtz). A few eyes showing corneal cloudiness and characteristic changes in the angle had tensions between 30 mm. and 35 mm. Hg.

After surgery cleared the cornea, Descemet's ruptures were frequently seen to be present. The prognosis was worse in eyes that showed severe symptoms at birth. Cases in the late distended stage of buphthalmus with corneal diameters of over 15 mm. are not recommended for goniotomy.

The results of goniotomy in the present series are summarized in Table 1 and Table 2.

The extent of the stripping was recorded diagrammatically on the record. Analysis by means of routine preoperative and postoperative gonioscopy with the microscope and hand slitlamp and consideration of all factors involved aided the management of the case and increased the percentage of good results. Normal pressure without miotics and gonioscopically demonstrable adequate exposure of the trabeculo-Schlemm's canal mechanism should be provided in all cases. Cases were re-examined at intervals of one, three, and six months, and after that at intervals of several months to a year.

TABLE 1

GONIOTOMY IN CONGENITAL GLAUCOMA

Number of infants and children operated	121
Eyes operated on by goniotomy	196
Successful (pressure normalized; vision maintained or restored)	152
Unsuccessful	36
Results not yet certain (incompletes)	8
Recurrence	10

TABLE 2

NUMBER OF EYES NORMALIZED BY GONIOTOMY, 152

In one operation	92
In two operations	37
In three operations	8
In four operations	10
In five operations	5

In recent years, goniotomy with and without the glass has been employed with success by many surgeons.[36–41]

Goniotomy with the surgical contact glass

The present technique of operating with the glass, although precise, is a safe and relatively simple procedure to one who familiarizes himself with it. It has been described elsewhere[6] but the following points deserve emphasis.

The eye is fixed by an assistant at the insertion of the vertical recti with sharp Gifford forceps with lock. The assistant must not dimple the sclera. The forceps is inclined to make room for the surgeon's left hand which controls the glass.

The surgeon is in the standing position almost upright and at shoulder level facing the patient. This affords greater flexibility in relative positions than when the surgeon is sitting. The head and eye of the patient are rotated away from the surgeon. The index finger of the surgeon's left hand controls the contact glass. The patient's eye should be adjusted to such a level that the surgeon's line of vision is at about a 45-degree angle from the vertical. The patient's eye is 47 inches above the floor for a surgeon of average height; the surgeon is looking downward at the temporal limbus of the eye.

In this position entry of air under the glass cannot occur provided that the surgeon keeps the glass positioned so that the corneal crescent remains exposed and the glass does not ride upon the shaft of the knife. The eye is abducted slightly in order that there is

ample room to push the glass nasally (canthotomy facilitates this). The anterior chamber is never lost if a correctly tapered knife[14] is used and it is not retracted during the operation.

After the initial puncture, the incision through the cornea is made rather oblique in order to encourage spontaneous reformation of the chamber and thereby prevent postoperative adhesions. It must not be too oblique lest it impede the passage of the tapered shaft of the knife as it traverses the chamber.

Air is injected postoperatively through the wound of entrance with a curved lacrimal cannula and two-cc. syringe while the head is turned to the operated side. The air should fill one half to two thirds of the chamber. If the head is rotated so that the bubble rises into the operative site, the raw surfaces of the angle are kept apart and the air is locked in the chamber.

If the miotic pupil is completely covered by air, some degree of air seclusion[15, 16] may be observed to produce a transitory bombé of the iris in its dependent portion while the infant is still on the operating table. The seclusion can be relieved if it is so desired by removal of air; or aqueous can be permitted to enter the anterior chamber and the bombé collapsed by shifting the air bubble from the pupil by means of external pressure exerted on the cornea with the tip of a glass rod. I have never seen an irreversible iris bombé or air glaucoma develop following goniotomy in infants.

If subsequent operations are necessary, they can be performed on other quadrants of the angle by the assistant rotating the globe around its axis. In several cases in which the nasal angle wall was scarred, as the result of previous goniotomies or cyclodialysis, a good result was obtained by operating across the nose on the untouched temporal angle.

Abrasion (total removal) of the clouded corneal epithelium with a keratome made it possible to operate under gonioscopic control with the glass in many cases in which it otherwise would have been impossible. Thus in the last 100 eyes operated upon 94 were operated with the glass under gonioscopic control. In four out of six eyes in which the operation was performed without the glass because of corneal cloudiness the reduction of pressure was only partial. However, the cornea cleared sufficiently so that the next operation could be performed with the glass.

Ruptures of Descemet's membrane sometimes made the operation under gonioscopic control a little more difficult because of the aberration which they caused but they could always be circumvented.

The point of the blade of the knife should be precisely localized in depth in order to assure a "teasing off" or superficial incision of the thin layer of aberrant tissue. Since in most infants the eyes are blue and the stroma transparent, the serrated edge of the pigment segments of the epithelial layer at the root of the iris are a prominent feature of gonioscopy and make an excellent landmark by which to judge where the point of the blade is to be placed, for example, close to the line of Schwalbe.

In the presence of a dark iris, the localization of the point in depth is more difficult because of lack of light in the angle and because the pigment serrations which provide a striking landmark in blue eyes are absent. In dark eyes it is therefore advantageous to use a magnifying loupe which makes it possible to see details of the insertion of the dark iris. This outweighs the sacrifice of depth of focus which is the result of the increased magnification.

Goniotomy without the surgical contact glass

In the presence of marked corneal cloudiness which cannot be relieved by abrasion, the periphery of the cornea is usually clear enough to attempt incision of the iridic angle without the aid of the contact glass. Good results can frequently be obtained in this manner. However, hazards are associated with the semiblind or blind technique and

accurate removal or incision of the thin superficial layer of obstructive tissue cannot be accomplished with the precision and consistency which is made possible by operating under direct vision, for example, under magnified gonioscopic control. Operating under the glass consists of more than the addition of a technical trick. There is the fundamental difference between the two procedures of operating blindly or by direct vision.

Urgency for early operation

The urgent need for early diagnosis and early operation in congenital glaucoma cannot be overemphasized. This is brought out by the tragic results of delay.

In some cases the effects of delay were noted while the patient was under observation. Thus, following postponement of operation for two to three weeks because of respiratory infection, cloudiness and distention increased markedly. In two cases two and three months old, nystagmoid movements developed in the course of three weeks. Prompt operation with normalization of tension resulted in disappearance of these movements.

In infants only a few days old in whom there had been no distention, the small size of the anterior segment makes goniotomy technically difficult. In such a case, when the corneal diameter is not more than 10 mm. and the anterior chamber is relatively shallow, a preliminary deepening of the anterior chamber by means of injection of saline solution through a prelaid self-sealing puncture facilitates the operation.[21]

It is well to operate on one eye promptly since the sooner pressure is relieved the greater is the reversibility of the corneal cloudiness and the opportunity of developing central fixation. In such a case it appears wise to postpone the operation in the second eye until the age of two to four weeks at which time the operation is easier to perform. The optic nerve does not suffer significant change as the result of pressure at this stage and age.

Analysis of unsuccessful cases

A review of the unsuccessful cases in this series suggests that failure to normalize pressure was due either (1) to congenital absence or marked insufficiency of Schlemm's canal as indicated by extreme cloudiness, high tension or distention at birth, or (2) to postoperative fibrosis or scarring of the angle wall. The latter was often the result of cloudiness of the cornea which had made it necessary to operate without the glass.

In some of these eyes, the incision was made too deeply and split the sclera. In others postoperative fibrotic tissue covered a blood-filled Schlemm's canal which could be seen in its characteristic position indicating that the lack of result was not due to absence of Schlemm's canal.

These observations convinced me that incision of the angle wall itself or scraping of it should be avoided because they cause fibrosis in the region of the trabeculum and Schlemm's canal and/or result in adhesions of the iris to the wall. The tissues of the infant eye appear to be more prone to form adhesions than those of the adult. Incidentally, this may be a reason for the ineffectiveness of cyclodialysis in infants. It may also explain why some attempts which I had made early in the series to separate the tissues in the angle with a blunt instrument (spatula) were ineffective.

Since the introduction of corneal abrasion which permits operation under gonioscopic control these difficulties have been largely eliminated.

Sympathetic ophthalmia has never occurred following goniotomy.

Recurrence of increased pressure

The result of the operation was considered successful when intraocular pressure was normal three months after operation without the use of miotics. Recurrence of pressure was not observed in cases in which the tension was normalized without drops three months after operation, gonioscopy showed the angle cleanly stripped and the iris re-

cessed over one quarter of the circumference.

It is my impression that repeated operations were necessary only in those cases in which scars or adhesions formed postoperatively or the exposed area was insufficient. In such cases the increased pressure was usually evident at the time of the first re-examination two to six weeks after operation.

In the cases in which the exposed area was too small, it had evidently sufficed to normalize the pressure for a few weeks but had proved insufficient to satisfy later demands made upon it for drainage. These cases have, therefore, been regarded as incompletes rather than recurrences. If, in such a case, a correctly placed superficial goniotomy is performed on another sector, it may be expected to normalize the pressure.

In some cases, goniotomy may have to be repeated several times before an adequately exposed area is obtained which is sufficient to normalize pressure permanently. With added experience and improved visibility incompletes, namely cases of repeated operation, have grown less in number.

Recurrence of increased pressure from six months to 13 years postoperatively occurred in 10 cases (table 3).

The recurrent tension was normalized in eight eyes by goniotomy and in two eyes by cyclodiathermy (with the aid of miotics).

Function of the trabeculo-Schlemm's canal mechanism

It seems remarkable that exposure of a relatively small area of trabeculum is sufficient to normalize tension. The explanation may be that the trabeculo-Schlemm's canal mechanism has much greater potential capacity for outflow than is necessary for physiologic demands. A partial exposure would therefore suffice for physiologic demands, provided that the exposed area is normally permeable and has not become scarred as the result of surgical trauma.

It may also be that access to aqueous is given to adjoining areas beyond the ends of the incision. It appears that in congenital glaucoma in most cases permeability of the trabeculo-Schlemm's mechanism is sufficiently adequate so that exposure of part of it permits normalization of pressure.

TABLE 3

Recurrences following goniotomy

Time Elapsed Since Operation	*Number of Eyes*
6 months	2
9 months	1
1 year	1
6 years	1
7 years	1
8 years	1
11 years	2
13 years	1

Mode of action of goniotomy: Its relation to technique and pathogenesis

The action of goniotomy appears to consist of re-establishing outflow to the trabeculo-Schlemm's canal mechanism. This view has been supported by all gonioscopic examinations, pre- and postoperative, and clinical observations made in this series.

There has been no evidence of external fistulization nor of the formation of a cleft communicating with the suprachoroidal space, although it is conceded that the latter may occasionally occur and be effective.

Goniotomy contraindicated in distended stage of buphthalmus

Goniotomy is contraindicated in the late distended stage of buphthalmus probably because Schlemm's canal has become obliterated. Operation may be hazardous because of the presence of dilated vessels. Also, as with all perforating operations on the advanced buphthalmic eye, sudden loss of intraocular fluid may result in retinal detachment or dislocation of the lens. Repeated cyclodiathermies over adjacent areas have been tried in these cases with some degree of success.

Goniotomy for glaucoma associated with aniridia

Goniotomy with the glass has been per-

formed on one eye in a case of aniridia.[19] Residual embryonic tissue had pulled the rudimentary root of the iris toward the line of Schwalbe, thus sealing off the angle from the chamber. Goniotomy released the adhesions of the iris stump and normalized the pressure.

Goniotomy for glaucoma associated with nevus flammeus

Glaucoma associated with nevus flammeus has in the past responded poorly to surgical intervention.

In two cases in the present series goniotomy with the glass normalized the pressure. This is the first time glaucoma associated with nevus flammeus has been operated by goniotomy.

One case was that of a girl, aged 11 years. When first seen on September 14, 1951, the tension was: R.E., 53 mm. Hg; L.E., 48 mm. Hg (Schiøtz) without drops. Miotics failed to reduce the tension; while under the influence of pilocarpine (four percent) and prostigmine (five percent) four times a day and eserine ointment (0.25 percent) every night, it remained at: R.E., 53 mm. Hg; L.E., 48 mm. Hg. There was melanosis bulbi and marked tortuosity of the retinal vessels in both eyes.

Gonioscopy showed the angle wall largely covered by uveal tissue giving the appearance of a reflection of the anterior stromal layer of the iris to the line of Schwalbe. This tissue was partially removed from the angle wall by three goniotomies in the right eye, and three goniotomies in the left eye. Convalescence was without incident. There was no hemorrhage.

In the right eye, tension has been normalized without drops up to the present time, a period of 11 months. In the left eye it was reduced to 28 mm. Hg with miotics. Final normalization without drops was achieved by a subsequent cyclodialysis.

At the present time, 12 months postoperatively, the tension is: R.E., 25 mm. Hg; L.E., 27 mm. Hg (Schiøtz) without miotics.

The other case was that of an eight-year-old boy. Gonioscopy showed similar but less marked aberrant tissue on the angle wall. The increased tension in the affected eye has been normalized by goniotomy with the glass up to the present time, a period of 16 months.

A detailed report of these cases will be published in a separate article.

These good results were achieved without hazard or disfigurement. They encourage the hope that goniotomy in the future may prove equally effective in other cases of glaucoma associated with nevus flammeus. The clinical importance of these results is evident. They are also significant from a theoretical point of view since the cause of the increased intraocular pressure in most cases of nevus flammeus has been assumed to be vascular on the basis of the hemangioma.[31-33]

Goniotomy with injection of air or saline solution

It has been stated by some authors that goniotomy with the glass is technically difficult because of loss of the chamber or entry of air under the glass. Consequently procedures were devised to obviate the difficulties.

In 1945, it was observed independently by Hughes and Cole[20] and by me[21] that air in the anterior chamber visualized the angle. Since, at that time, goniotomy with the contact glass was still attended by some technical difficulties, I tried operation through the air-filled chamber.

The general location of the angle and root of the iris could be made out but visibility was much disturbed by surface reflections, by the meniscus in the angle, Descemet's folds, and ruptures of Descemet's membrane. There was also loss of magnification which cannot be compensated by the use of a loupe because the loupe also magnifies the reflections and irregularities produced by air.

Continuous inflation of the anterior chamber with air injected through a sharp cannula was also tried. Vision through the air-filled chamber was in no way comparable to

that obtained through glass and fluid. These techniques were therefore discarded.

Lindner* reports good results while operating under continuous injection of Ringer's solution using a dull discission knife inserted through a prelaid puncture. He operated without the glass.

Recently a sharp cannula has been devised by Stepanik[22] which, inserted through a prelaid puncture in the limbus, allows continuous injection of air or, at the suggestion of Lindner, of Ringer's solution.

The difficulties encountered in the early stage of development of the operation with the glass have long since been overcome. During the last several years, there has not been a single instance of loss of aqueous or of air entering under the glass. With this technique and using the present model of surgical contact glass and knife,[14] the operation with the glass presents little difficulty to the surgeon who has familiarized himself with it.

Safety of goniotomy

Goniotomy, even when unsuccessful, does no damage to the globe. In the last 150 eyes in this series, since the development of the technique, no complication has occurred. Another procedure can be subsequently applied without disadvantage.

External fistulizing operations: Cyclodialysis and cyclodiathermy

Trephining and iridencleisis are often mutilating and not uncommonly result in cataract formation, hammock iris, staphyloma, atrophy of the globe, and occasionally in sympathetic ophthalmia.[10, 28, 29]

Attempts to obtain fistulization in congenital glaucoma by means of sclerotomy can be traced back to anterior and internal sclerotomy single, multiple, or repeated as practiced by de Wecker and others[23-26] until recent times. It consisted of puncturing the anterior chamber behind the limbus, crossing it, and counterpuncturing the other side through or under the conjunctiva. The openings were made of different sizes. These operations were largely ineffective and not without hazard.

De Vincentiis in 1892[17, 18] in his original operation of incision of the iridic angle did not counter-perforate the sclera. His objective was a pure debridement of the angle. De Wecker[23] combined with de Vincentiis' method a counterpuncture or sclerotomy in the hope of adding the benefits of external fistulization (if any) to those of internal debridement. This combined method he called "internal sclerotomy." Rochon-Duvigneaud[25] also used a restricted scleral puncture and called the operation "reduced sclerotomy."

Early in my series (1936-1938) when performing the operation without the glass, a limited counterpuncture of the sclera into the subconjunctiva was added in over 20 eyes in the belief that external fistulization might be a factor in the action. However, in none of these cases did permanent fistulization occur. In all cases normalization of pressure seemed to parallel the stripping of the angle. The punctures were a slight additional hazard often leading to adhesions of the iris to the scleral wall. The sclerotomies were therefore discontinued.

Interest in fistulization by means of internal, limited, or reduced sclerotomy has recently been revived by Scheie[27] who calls his technique "goniopuncture." In five eyes afflicted with congenital glaucoma followed for six months he reported normalization of pressure by fistulization in two and partial reduction in one. Subsequently, he combined the sclerotomy with goniotomy (without the glass). Unfortunately the combination prevents evaluation of the effect of sclerotomy as an isolated procedure.

Cyclodialysis is rarely effective. It appears that the tendency of the infant to form adhesions prevents the success of this operation. Later in childhood and youth it is more effective especially in those cases of late congenital glaucoma which are caused by a reflection of iris stroma onto the angle wall.

* Personal communication.

Cyclodiathermy is popular on the continent of Europe for all stages of congenital glaucoma as a primary operation.[28, 30] In this series it has been the procedure of choice if goniotomy has failed. However, serious complications have also been reported following cyclodiathermy such as detachment of the retina, atrophy of the globe, and sympathetic ophthalmia.

For a comprehensive review of the treatment of infantile glaucoma the reader is referred to Anderson[10] and to the recent study of this subject by Algan.[28]

Conclusion

The intraocular pressure, corneal diameter, and visual disturbance in congenital glaucoma are evaluated.

Goniotomy (with the glass under gonioscopic control) is indicated for congenital glaucoma before excessive distention has occurred. Removal of the cloudy epithelium (abrasion) permitted operation with the glass in many cases in which it heretofore was impossible. In the last 100 eyes operated upon, 94 were operated with the glass under gonioscopic control. The stripping should be limited to a superficial teasing off or incision of the aberrant tissue.

In some cases which had to be operated without the glass because of severe corneal cloudiness partial reduction of pressure cleared the cornea sufficiently to permit subsequent operation with the glass.

Results of successful normalization of pressure by goniotomy in glaucoma associated with aniridia and in glaucoma associated with nevus flammeus are reported.

The relation of the mode of action of goniotomy to technique and pathogenesis is considered.

Other techniques and other operations for congenital glaucoma are discussed.

490 Post Street (2).

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AN EPIDEMIC OF CONJUNCTIVITIS IN COLORADO*

Associated with pharyngitis, muscle pain, and pyrexia

T. Aidan Cockburn, M.D.
Greeley, Colorado

Introduction

In August and September, 1951, in Greeley, Colorado, there appeared an epidemic of a disease with an unusual combination of features consisting of acute conjunctivitis, vesicular pharyngitis, muscle pains, and pyrexia.

In most cases the presenting ailment was an acute, nonpurulent conjunctivitis, often followed by a mild keratitis, but in some instances conjunctivitis was lacking and the other features predominated. The pharyngitis was characterized by vesicles on the postpharyngeal wall and fauces and usually was accompanied by muscle pain and systemic symptoms.

A large proportion of the patients displayed all the eye, pharyngeal, muscle, and general systemic manifestations at the same time. On epidemiologic grounds it would seem likely that these manifestations were all the result of one type of infection. For the sake of convenience this infection will be referred to in this paper as "Greeley disease."

Methods

Case finding technique

Greeley, Colorado, is an agricultural town of 21,000 population, about 20 miles from the Rocky Mountains. It is the center of a large farming area and enjoys a heavy tourist traffic in the summer.

On August 9, 1951, Dr. D. J. Barber, pediatrician of Greeley, Colorado, reported to the Encephalitis Investigations Unit in

* From the Communicable Disease Center, USPHS, Department of Health, Education, and Welfare.

Greeley the case of a boy aged eight years (Case 1) whose illness had been first diagnosed tentatively as poliomyelitis, but after some days this had seemed unlikely and the possibility of encephalitis was then considered. This boy had become ill with muscle pains, stiff neck, and pyrexia on the first of August; there had been no increase in cells in his cerebrospinal fluid.

When seen by me on August 9th, he was found to be recovering from these symptoms but suffering from an acute nonpurulent conjunctivitis.

A search for further cases in Greeley with the assistance of the Weld County Public Health Department and physicians of the Weld County Medical Society resulted in the finding of a substantial number of additional cases, often associated with pharyngitis. Some of the cases had been diagnosed as poliomyelitis, although examination of the cerebrospinal fluids had shown no abnormalities.

The epidemic was given publicity in the press with the request that cases be reported to the Public Health Department. Further cases were reported by the Public Health nurses on duty at schools and at the Colorado State College of Education. News of the illness quickly disseminated throughout the town by word of mouth and some patients reported directly to the unit.

A total of 206 cases were eventually reported to this unit, 58 of these being seen and investigated either by Miss Albina Bozym, Public Health nurse, CDC, or me, while another 56 were treated by physicians in the town and reported to the unit. The data given herein deal only with the 58 patients seen by Miss Bozym and me.

Clinical investigations

None of the cases were admitted to the hospital, all being seen in their homes. The routine clinical examinations were supplemented in six cases with marked muscle pains with lumbar punctures. In 52 instances, patients with conjunctivitis were examined with the slitlamp for evidence of keratitis two to three weeks after onset by Dr. W. H. Droegemueller and Dr. D. T. Jennings, ophthalmologists of Greeley.

Laboratory procedures

Eye washings and scrapings were plated on blood agar, and on chocolate agar in CO_2. Throat washings were plated on blood agar. Conjunctival scrapings were stained with Giemsa and examined for inclusion bodies.

Eye washings, throat washings, whole blood, and paired acute convalescent sera were collected for attempts at isolating the causal agent. In addition, four convalescent sera were tested by Dr. Martha K. Ward, CDC, for agglutinating antibodies against 10 types of leptospira.

Results

Clinical investigations

1. *Conjunctivitis.* A moderately severe follicular inflammation without any purulent discharge. The patients were not unduly uncomfortable, and few complained of any real pain or photophobia. There was little edema and no sign of false membrane formation. Usually only one eye was initially affected, but sometimes the other became involved a few days later.

The conjunctivitis persisted for three days to three weeks, average duration being about a week. In 13 out of 54 cases, when examined by the slitlamp three weeks after onset, the corneas were found to have small whitish plaques one mm. or less in size. These plaques appeared to be subconjunctival and apparently were not associated with ulceration.

2. *Throat lesions.* Soft-walled vesicles, ranging in size from a pinhead to a pea, were frequently found on the soft palate, fauces, or base of the tongue. When these had been broken ulcers formed which lasted for several days. Often when no vesicles were present the fauces were deeply injected, and sometimes tonsils were enlarged and deeply red.

3. *Glands.* In only three of the 58 cases examined in Greeley the preauricular glands were found to be enlarged. In every case, however, small glands were present in the neck, but these were never numerous and always remained small.

4. *Temperature.* The majority of the patients examined, especially those with severe lesions, ran temperatures of the order of 102.5°F. to 105°F. for one to five days, although some of the milder cases had temperatures only elevated a degree or two. In a number of cases, the temperature returned to normal after a few days but became elevated again a second time after a further few days.

5. *Muscle pains.* A substantial proportion of the patients reported that they had pains in their backs or legs or had stiff necks. The presence of an epidemic of poliomyelitis in Colorado led to the diagnosis of this disease in a number of instances, but in the few instances in which spinal punctures were performed there were no increases in cells in the cerebrospinal fluid, and all cases made an uneventful recovery. None of the cases in the epidemics studied developed paralysis.

Laboratory studies

No bacterial pathogens were recovered from the eye scrapings and washings. No inclusion bodies were seen in conjunctival scrapings. Bacteriologic studies of the throat washings failed to incriminate any organism likely to have been the causal agent. The convalescent sera tested against Leptospira were reported negative. Although etiologic studies are still in progress, up to the moment no definite causative agent has been recovered.

Epidemiology

Chronology of the epidemic

The total number of cases reported was 206. The dates of onset of the 58 cases seen by Miss Bozym or me are given in Chart 1.

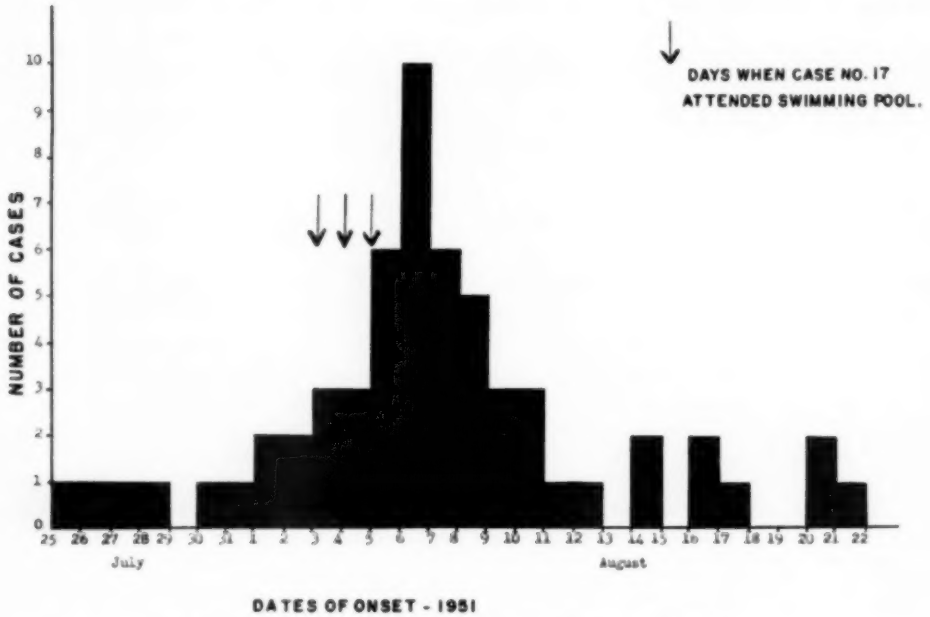

Chart 1 (Cockburn). Greeley disease. Chronology of epidemic.

TABLE 1

DISTRIBUTION BY AGE

Age (years)	Conjunctivitis with or without Pharyngitis	Pharyngitis without Conjunctivitis	Total
1	0	0	0
1–4	2	4	6
5–8	13	2	15
9–12	7	4	11
13–16	14	2	16
17–20	6	1	7
Over 20	2	1	3

It will be seen that in July a number of sporadic cases were occurring but that in early August an explosive outbreak appeared covering a period of eight to 10 days, and that afterward the pattern of sporadic cases reappeared. The peak number of cases was on August 7th.

AGE AND SEX DISTRIBUTION

The ages and sexes of the patients in the 58 cases investigated are given in Tables 1 and 2.

It will be seen that slightly more males were affected than females and that all the patients with only three exceptions were under 21 years of age. It will be shown later that one of these three exceptions was a mother who infected herself from her child.

MODES OF INFECTION

All 58 patients investigated were questioned as to their movements and actions prior to the onset of illness, and it seemed likely that the spread of infection had been partly by direct transmission and partly through the local swimming pool.

Two examples of direct transmission of infection were discovered. Case 49 was the mother of a child, aged 10 years (Case 33) who had conjunctivitis. The mother became impatient with the child's response to treatment prescribed by the physician and treated the child herself by squeezing ointment from a tube on the child's eye, touching the eyelid as she did so. She then treated her own eyes as a prophylactic, touching her lids in the process, and three and one-half days later developed a marked conjunctivitis in both eyes.

In another instance, Case 78, a child, aged five years, attended a birthday party where one of the children had an inflamed eye. A toy viewer which had been brought as a gift was passed from child to child, and each pressed it against his or her eye; and in the instance of Case 78, conjunctivitis developed three days later. The mother stated that two other children in the party also developed similar symptoms at the same time.

The swimming pool was incriminated because so many of the patients gave a history of attending there a few days before becoming ill. The pool is the only open air one in Weld County and is used not only by the people of Greeley but also by large numbers of people from the district around. Large organized parties of children visit from the neighboring small towns. The water used in the pool is recirculated and heavily chlorinated, the residual chlorine being at least 0.4 parts per million.

TABLE 2

DISTRIBUTION BY SEX

Sex	Conjunctivitis with or without Pharyngitis		Pharyngitis without Conjunctivitis	Total
	One Eye	Both Eyes		
Males	16	12	7	35
Females	7	9	7	23
Totals	23	21	14	58

Out of the 44 patients with conjunctivitis, 31 gave a history of swimming in the pool within 10 days prior to becoming ill and in the group of 26 people whose onset of illness was in the period August 5th to 8th (Chart 1), no less than 20 of them had been in the pool on the weekend of August 4th and 5th. Questioning of leaders of children's groups who had attended the pool on those days confirmed that many of their children had become ill the following week, and a conservative estimate of the total number between the ages of five to 16 years would be approximately 100 children.

An attempt was made to estimate the attack rate of the illness among those attending the pool on August 4th and 5th, and compare it with that of the town as a whole. The population of Greeley in 1950 was approximately 21,000 and among these there were 206 cases reported, giving an attack rate of 0.98 percent.

The size and age of population in the swimming pool on August 4th and 5th can be estimated from the number of tickets sold, for there were two charges, one for juveniles 16 years and younger and the other for adults. The majority of the adults were students from the high school or state college of education and in their late teens and early twenties. The attendance is given in Table 3.

Making allowance for the large parties of children from outside of town and for those children who swam in the pool on both Saturday and Sunday, it would seem likely that 200 to 400 children of Greeley under 16 years of age were in the pool for many hours on either or both of those days. Probably at least 100 of those became ill within 10 days, giving an attack rate of 25 percent to 50 percent.

TABLE 3

SWIMMING POOL ATTENDANCE

	Adult	Juveniles	Total
Number in attendance Aug. 4th	351	279	630
Number in attendance Aug. 5th	178	263	441
TOTAL	529	542	1,071

To test the theory that the swimming pool was the focus of infection, inquiries were made some miles away at the small towns of Windsor and Eaton to see if any cases could be found there. Seven cases were found at Windsor and two at Eaton, and all except one had been swimming in the pool a few days prior to the onset of the illness. The one exception, at Eaton, was the mother described earlier who apparently transmitted the infection directly from her child's to her own eyes. Another patient reported for Cheyenne, 50 miles away, was found to have returned home to Greeley for a day on August 5th and had been in the pool.

SOURCE OF INFECTION

In the course of the questioning of the patients, the mother of one of them, Case 17, volunteered the statement that her son had become ill on August 2nd with an acutely inflamed eye, but had been well enough to visit friends and go out of doors. He had pestered her to allow him to go swimming and permission had eventually been given on August 3rd, 4th, and 5th, "providing he kept his head out of the water" (Chart 1).

STUDIES IN OTHER AREAS

In August, 1951, epidemics of conjunctivitis were reported in Neosho, Missouri,* by Dr. E. A. Belden, State Epidemiologist for Missouri, and in a number of towns of Colorado, particularly Boulder, Delta, and Alamosa, by Dr. Roy Cleere, State Health Officer. Quick visits were made to Neosho, Missouri, and Delta, Colorado, to see if the same "Greeley disease" was being presented in these areas.

In Delta, Dr. L. L. Hick, physician, had reported many cases that closely resembled the disease and on investigation it was

* Public Health Reports, August, 1951.

found that in the general area around Delta many thousands of cases had been seen by local physicians in the months of July, August, and September.

This illness sometimes was confined to a nonpurulent conjunctivitis, sometimes was a vesicular pharyngitis, and some of the patients had high pyrexia and severe muscle pains that were often diagnosed as nonparalytic poliomyelitis. Many patients had all the symptoms. The infection was apparently transmitted to a large extent by familial contact.

A similar epidemic was found in Neosho, Missouri, in the same months, again with some thousands of cases. The leading clinic in the town reported seeing about 100 cases a day in August. Here again the same combinations of symptoms were found.

Discussion

The results of the laboratory work undertaken to clarify the etiology of the "Greeley disease" described in this paper have so far been unproductive and no definite agent has been incriminated. Epidemiologically, the disease appeared to be a distinct entity, although the conjunctivitis resembles a mild form of epidemic keratoconjunctivitis and the vesicular pharyngitis and muscle involvements resemble the symptoms of Cosackie infections.

There were clinical and epidemiologic differences between the epidemics in Greeley, Neosho, and Delta, but in all these places, many hundreds of miles apart, the same features of acute nonpurulent conjunctivitis, vesicular pharyngitis, pyrexia, and muscle pains appearing in epidemic form in the warm months of the summer were found.

The evidence in favor of transmission of infection in Greeley by the swimming pool is circumstantial, but the very high attack rates of those who attended on August 4th and 5th compared with low rate of the remainder of the town, together with the similarity in the ages of those attacked and those attending the pool are highly significant. Attention is drawn to the fact that chlorination of the pool was carried out according to accepted standards, yet apparently failed to prevent transmission of this disease.

Summary

1. An epidemic of acute nonpurulent conjunctivitis sometimes followed by keratitis and associated with a vesicular pharyngitis, and general systemic symptoms is described.

2. Transmission of the diseases apparently occurred either by direct transfer of infected materials or by association with a swimming pool.

3. Two other epidemics were found in Missouri and Colorado with the same combination of symptoms and occurring in the same months of the year.

Department of Health, Education, and Welfare.

The assistance of physicians and Public Health nurses in Greeley and Delta, Colorado, and Neosho, Missouri, is gratefully acknowledged.

Ophthalmic Miniature

. . . By a repeated inattention to a proper regimen, we may not only incur a constant weakness of the sight, but even superinduce total blindness.

H. Colburn, London, 1816,
The Art of Preserving the Sight Unimpaired to an Extreme Old Age.

A NEW OPHTHALMOMETER

HANS LITTMANN, M.D.
Heidenheim, Germany

The ophthalmometer about to be described* differs essentially from such instruments hitherto used in ophthalmic practice not only in its external appearance and mechanism but above all in its optical system. It possesses indeed only one feature in common with the customary instruments, namely, that it utilizes the distance between two mires reflected in the cornea to determine the corneal radius, refractive power, and astigmatism.

It has been usual for the ophthalmometer mires to be reflected directly in the cornea by means of light transmitted through them. In the present instrument, however, they are imaged by a condensor system. On this and because of the high light-transmitting power of the internal optics of the ophthalmometer, the mire images appear so brightly in the eyepiece that measurements can be completed in a well-lighted room or in daylight.

Furthermore, the eye under examination and its pupil are visible in the eyepiece at the same time as the mire images. This is a particularly valuable feature since the instrument can be so directed that the mire images are obtained from any part of the cornea it is desired to measure.

In the case of an eye with an undamaged cornea, the two mires will be set symmetrically to the corneal vertex (or pupil center) in order that that part of the cornea may be examined which is of the most importance in respect to refractive power and curvature of astigmatism. In other cases, as for instance when it is desired to measure a corneal transplantation, the mires are directed to the requisite area of the corneal surface.

It is important that the operator be able to check the correct centering of the patient's eye with the ophthalmometer throughout the measurement.

This is of greater significance than may at first appear. Experience with the present instrument has shown that the customary method of controlling the centering, by means of a fixation target alone, falls far short of requirements. If the patient's gaze departs unconsciously and without being noticed from the correct direction, the mire images in the field of view of the ophthalmometer will move in a lateral direction and a decentration may thereby result. The operator, however, is invariably inclined to compensate for the displacement of the images—in so far as he notices it at all—by a corresponding lateral movement of the ophthalmometer.

By means of this faulty compensation, it is true that the mire images are returned to the center of the field, but the instrument is no longer correctly centered to the eye. In consequence, errors of some diopters may result not only in the computation of the corneal refractive power but even in that of the astigmatism.

It is furthermore essential for the mire images on the cornea to lie very close to each other so that very small surface elements are also measurable. In the case of as normally curved cornea of 43D., a surface area of only some three mm. is sufficient for an exact measurement.

The ophthalmometer mires are simple and distinct. They consist of only a hollow cross and a single cross which are brought to coincide as illustrated in Figure 1.

This coincidence is obtained in the first principal meridian and the ophthalmometer is then rotated through 90° to the second principal meridian and coincidence again obtained. The ophthalmometer then immediately indicates, adjacent to the other measurements, the amount of the corneal astigmatism.

At first glance this procedure may appear

* Manufacturer: Zeiss-Opton, Oberkochen, Germany.

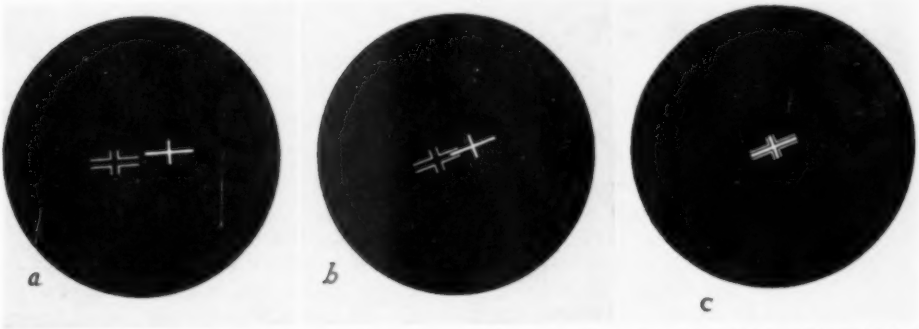

Fig. 1 (Littmann). The ophthalmometer mires: (a) Not yet adjusted for the position of the principal meridian and the refractive power. (b) Adjusted for the position of the principal meridian. Not yet adjusted for the refractive power. (c) Adjusted for the position of the principal meridian and the refractive power.

to compare unfavorably with that followed in the Sutcliffe ophthalmometer, in which a mire in each principal meridian is brought into contact with a central mire. But the fact is that even in the Sutcliffe ophthalmometer the mires are not brought simultaneously into contact because the operator cannot observe both procedures simultaneously. The true advantage of the Sutcliffe instrument lies in the fact that, with it, there is a greater probability of the corneal refraction in the two principal meridians, being measured on the same portion of the corneal surface. This is, however, also readily achieved with the present instrument because the mires are seen together with the cornea.

An almost unrecognized source of error in ophthalmometric measurements is the distance error which arises when the ophthalmometer is not set at the distance from the patient for which the recording scales have been calculated. For reasons which have been thoroughly explained elsewhere[2] distance errors appreciably falsify the resultant measurement, particularly in those cases in which the corneal curvature and refractive power are being measured as, for example, in the fitting of contact glasses or in recording pathologic changes in the corneal curvature (keratoconus, and so forth).

If the distance of the instrument from the patient departs by one percent from the correct value, an error of two percent arises in the determination of the corneal refractive power and astigmatism.

A distance error of this magnitude, which frequently occurs in practice, results, for example, in a corneal refractive power of 43D. being measured erroneously to the extent of 0.86D. too high or too low. The distance error is, however, often appreciably greater than this.

In measuring the astigmatism, the distance error is, because of the small amounts of corneal astigmatism, not of great significance.

Distance errors arise: (1) When the mire images are imperfectly focused, and this may be the case even when the operator considers he sees the images in the eyepiece sharply; (2) when the eyepiece is incorrectly adjusted; (3) when the operator unconsciously accommodates.

Strangely enough, all ophthalmometers hitherto in use are subject to distance errors of the degree just mentioned, although, a century ago, Helmholtz explicitly pointed to the need to prevent this error and even described an optical system which was not subject to it.[3] This system is found in the Helmholtz ophthalmometer in which the mire images are displaced by means of two contrarotating parallel plane glass plates.

Methods have been introduced into some

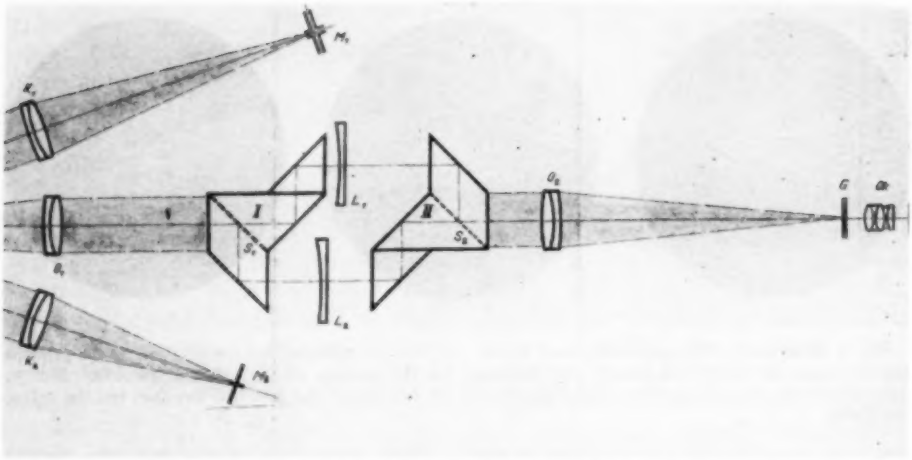

Fig. 2 (Littmann). The optical principle of the Zeiss-Opton ophthalmometer.

modern ophthalmometers for the purpose of ensuring that the correct working distance is constantly retained. Examples of these are the system of supplementary mires which become doubled with any departure from the correct distance, and marks in the eyepiece which indicate the correct image plane. All of these methods, however, demand the attention of the operator during the process of measurement so that his attention is diverted from his true task. It is unquestionably far more convenient for the operator to use an instrument which is simply not subject to the distance error.

Helmholtz's instrument satisfied this requirement to a very great extent.* It is, however, not really suitable for present-day demands in image brightness and definition, because the glass plates lying obliquely in the path of the rays adversely affect the quality of the image when a high light transmitting system, that is, of wide aperture, is employed. And this latter condition is essential for the achievement of perfect ophthalmometry. It is on account of these considerations that the new ophthalmometer now to be described has been developed.

In Figure 2 M_1 and M_2 are the two mires which are imaged at infinity by the two collimator objectives K_1 and K_2. The corneal reflex images lie in the focus of the ophthalmometer objective O_1. The parallel pencil of rays proceeding beyond the objective O_1 is split into two by the semitransparent mirrored surface S_1 within the prism combination I.

These two separate pencils then penetrate the two lenses L_1 and L_2 which lie exactly in the focal point of the objective O_1. By means of the measuring mechanism they can be moved in opposition to each other, perpendicularly to the optical axis, and they thereby produce the coincidence of the reflex images.

The two pencils are reunited by the semitransparent mirrored surface S_2 within the prism combination II and then penetrate in unison the objective O_2 in the focal plane of which the mire images are formed. The mire images in turn are imaged by the ocular OK.

This system is wholly free from distance errors because it realizes the following three principles:

The ophthalmometer mires lie optically at

* To satisfy this requirement to the utmost the geometric division of the pencils of rays must be replaced by an energetic division. This is explained in detail in Reference 2.

infinity because they are imaged there by the collimators K_1 and K_2.

The system observes the principle of the telecentric path of rays, achieving this by the fact that the two movable lenses, L_1 and L_2, which displace the two separated pencils, lie exactly in the focal plane of the objective O_1.

The division of the two paths of rays is effected energetically by means of the semi-transparent mirrors S_1 and S_2 and not geometrically by a division in the objective aperture. This last factor is very significant. It is not observed for example by instruments based on the design of the Sutcliffe ophthalmometer.

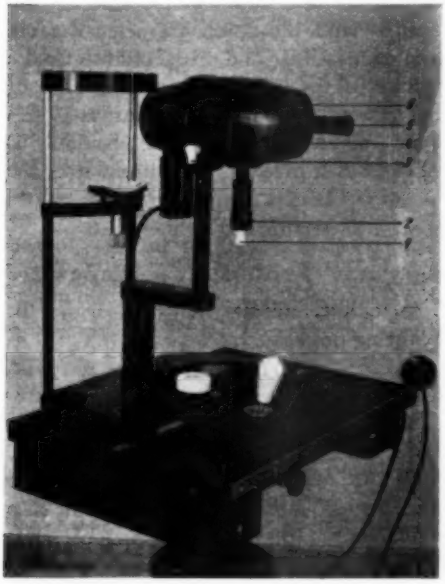

Fig. 3 (Littmann). The ophthalmometer set upon the instrument table.

1. Drum for adjusting the instrument to the corneal refractive power.
2. Drum for adjusting the instrument to the corneal astigmatism. (1) and (2) together form an extension of the lever by means of which the instrument is rotated about its long axis.
3. Locking device for the first principal meridian and automatic stop for securing the position of the second principal meridian.
4. Eyepiece in which the principal meridian and the astigmatism are read.
5. Ophthalmometer eyepiece.
6. Eyepiece in which the corneal curvature and the corneal refractive power are read.

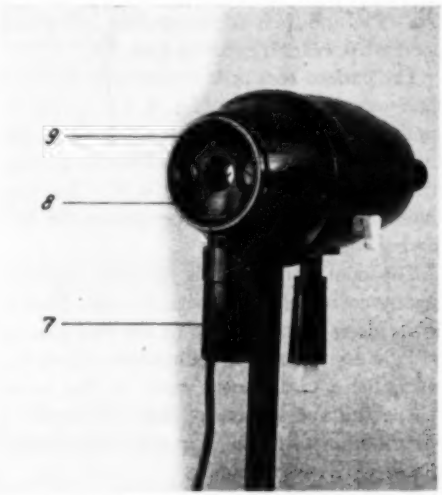

Fig. 4 (Littmann). Front view of the ophthalmometer.

7. Lamphouse.
8. Ophthalmometer objective.
9. Illumination condensers.

The external appearance of the ophthalmometer is shown in Figures 3 and 4. The instrument stands on an instrument table which has been described elsewhere[3] and by means of which the necessary centering to the eye and the focusing are effected. The ophthalmometer has been so designed that its operation requires the minimum attention. It requires no adjustments and possesses no means of effecting any. The setting for the axis position, the corneal refractive power, and the astigmatism is made with a single control (fig. 3, 1 and 2).

The mire images and the patient's eye are observed in the eyepiece (fig. 3, 5). The measurements are read in the eyepiece (fig. 3, 4 or 6) in which the illuminated recording scales are visible and set at infinity so that even presbyopes can easily take the readings.

The principal meridians and the corneal astigmatism, that is, the values chiefly required in routine practice, are indicated in the eyepiece (fig. 3, 4). The individual cor-

neal radii and their corresponding refractive powers are read in eyepiece (fig. 3, 6).

The patient sees in the middle of the ophthalmometer objective (fig. 4, 8), a red, illuminated fixation target set almost at infinity. Left and right of the objective are the illumination condensors (fig. 4, 9). The ophthalmometer is normally operated in the following manner:

The ophthalmometer is first set approximately correctly to the patient's eye. This is easily done with the help of the two pencils of light emitted by the collimators (fig. 4, 9), since these two pencils meet at the point where the eye should be, and the surfaces they illuminate on the eye are easily recognized.

The operator then looks into the eyepiece (fig. 3, 5) and focuses the mire images sharply by means of the joy-stick on the instrument table. At the same time they are brought to coincide by means of the rotatable drum (fig. 3, 1). If, because the mires are not on the same level, this is not possible, the same drum (fig. 3, 1) is used to rotate the entire instrument about its long axis until the images are correctly set at the same height. The ophthalmometer is then set at the first principal meridian of the eye (fig. 1).

Without stopping to take the reading usually necessary at this point, the operator now releases the locking lever (fig. 3, 3) and with the lever (fig. 3, 2) continues to rotate the instrument about its long axis as far as it will go. This position is automatically secured within the instrument by a lever (fig. 3, 3) so that the instrument is turned through exactly 90 degrees from the first position in arriving at it, and it is now set at the second principal meridian. If the mires no longer coincide, thus indicating the presence of corneal astigmatism, they are again brought to coincide by a slight turn of the drum (fig. 3, 2).

All operations are now completed and the operator can immediately read in the eyepiece (fig. 3, 4) the first principal meridian, which has remained recorded in the instrument, and the amount of the astigmatism.

The ophthalmometer can also be used without the various automatic devices if the locking of the lever (fig. 3, 3) is omitted. In this case the refractive powers only are measured with the drum (fig. 3, 1), the relevant principal meridians being read in the eyepiece (fig. 3, 4) and the individual refractive powers or curvatures in the eyepiece (fig. 3, 6).

One division of the dioptric scale represents 0.25D. A quarter of this amount, that is, 1/16D. can be visually judged without difficulty. The accuracy of the readings obtainable with the ophthalmometer has not been increased beyond this. To do so would, because of the physiologic irregularities of the cornea, serve no useful purpose. This ophthalmometer may, however, justifiably be regarded as a precision instrument since the results obtained are, because of the optical principles employed, absolutely reliable.

Summary

An ophthalmometer which possesses the following properties is described:

1. The optical system provides mire images of such brightness that all measurements can be undertaken in a well-lighted room. This means furthermore that not only the mire images but also the eye under measurement is visible in the field of view of the instrument so that it is possible while measuring to control the positions of the mire images on the cornea and thus exclude faulty readings.

2. The distance separating the two reflex images of the ophthalmometer mires on the cornea is exceptionally small. It is, for example, possible in the case of a normally curved cornea to take the measurements of transplantations only three mm. in diameter.

3. The operation of the instrument is to a great extent automatic; single control, automatic setting of the second meridian, immediate reading of the corneal astigmatism

and the axis in a single field simplify the handling of the instrument.

4. The instrument is equipped with an optical system of entirely new design which results in the measurements obtained being free from focusing and accommodation errors and also quite unaffected by the distance of the instrument from the patient.

Zeppelin strasse 13.

The ophthalmometer herein described was designed by Mr. B. Mueller, whom I wish to thank for his co-operation.

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THE EFFECT OF THE HARDERIAN AND LACRIMAL GLANDS UPON REGENERATION OF THE CORNEAL EPITHELIUM*

George K. Smelser, Ph.D., and V. Ozanics, M.S.
New York

The effect of many agents on regeneration and mitotic activity of normal and injured corneal epithelium has been the subject of extensive investigation in recent years.[1-4] During a search for solutions or vehicles which, when applied to the intact or injured cornea, would create the optimum environment for that epithelium,[5] it was thought that the tears provided such milieu, possibly because of enzymes or metabolites they contained, or through the maintenance of proper pH and osmotic relationships. To test this assumption, the rate of healing of corneal injuries and the number of mitotic figures found in regenerating and intact corneal epithelia were determined in eyes deprived of their lacrimal secretions.

The rat's cornea is covered by secretions from two large glands, a lacrimal (homologous with that in man) which is divided into an extraorbital (temporal) and orbital portion, and the Harderian gland. The first is a serous gland, whereas the latter secretes a great many lipids and porphyrins

Since these glands are unlike, three experiments were performed. In one group, only the lacrimal gland was removed, in another only the Harderian gland, and in the third both glands were removed. In these experiments litters were divided so that comparisons of the results of all three experiments could be made between litter mates.

Materials and Methods

One hundred and fourteen male Sherman-strain rats were used in the present study. They were raised on the Rockland rat diet supplemented with a chick mash fortified with brewers' yeast and cod-liver and vegetable oils.

Fourteen days after birth the Harderian glands were removed from the right orbits. The right lacrimal glands, both temporal and orbital portions, were ablated when the rats were 26 to 28 days of age. The left orbits were unoperated in all cases.

At 38 to 40 days of age, standard thermal burns were inflicted on both corneas of 95 rats. These burns extended horizontally from limbus to limbus and were made by a five-second application of a Shahan thermophore equipped with a terminal 1.5-mm. wide, fitted to the curvature of the rat's cornea and heated to 71°C. The entire thickness

* From the Department of Ophthalmology, Columbia University, College of Physicians and Surgeons. This investigation was supported by a grant from the Ely Lilly Company.

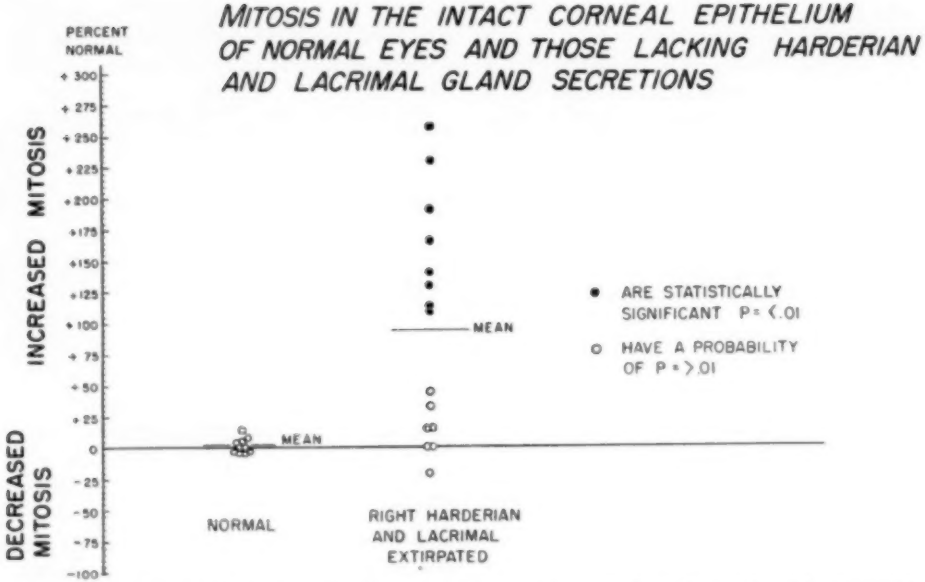

Fig. 1 (Smelser and Ozanics). Each point represents the number of mitotic figures found in the experimental cornea, expressed as a percent of those in the control eye. The normal group, in which both corneas were intact, show the variation between the right and left eye.

of the epithelium was destroyed but damage to the stroma was minimal. Injuries of this size were covered by epithelium in 15 hours in normal control animals.

The burns were made early in the morning and the rats kept undisturbed in a quiet place until killed by decapitation 12 hours after each burn was inflicted. The eyes and lids were fixed in Bouin's fluid, which made the unhealed area of the burn and the approximating wound edges distinctly visible.

The outline of this unhealed portion was drawn with the aid of a camera lucida and the area of the drawing measured with a planimeter. The effect of deprivation of tears on the rate of healing was thus shown by comparison of the wound area measurements of the left (normal) and right (tear-deficient) eye.

Both corneas of each rat were embedded in the same paraffin block and cut simultaneously, so that each slide had representative sections of the experimental and control cornea. The plane of section was vertical and thus passed perpendicularly through the burned strip, as well as the lids.

The mitotic figures from 15 representative sections taken throughout the burned area of each cornea were counted. The difference between each experimental animal and its control was determined and the probability that the difference was significant was calculated. In 10 cases the corneas were not burned, but were studied to determine the effect of only the ablation of the Harderian and lacrimal glands on mitosis in intact epithelium.

A. Intact corneas

Removal of both the Harderian and lacrimal glands had no apparent deleterious effect on the cornea, excepting that in most instances the operated eye had a slightly dull surface instead of the brightly reflecting one of the unoperated eye.

When the number of mitotic figures in the right and left corneal epithelia of normal eyes is compared, a variation of a few percent is usually found.[3] In about one half of

the cases one cornea may normally contain more mitoses (about 10 percent) than the other.

The number of mitotic figures in the present experiments, however, was markedly elevated in the corneas deprived of the Harderian and lacrimal secretions. This increase averaged 90 percent and occurred in 12 of the 15 cases studied. The control corneas were within the normal range (fig. 1).

The Harderian gland alone was removed from the right orbit of three additional rats, and the number of mitotic figures in the left and right corneal epithelia was determined. The luster of the cornea was not affected by removal of Harder's gland, nor was the number of mitoses.

The right lacrimal gland was removed from five additional rats in which Harder's gland was left intact. The cornea became lusterless and the number of mitotic figures was definitely above normal in the cornea in three of these five animals.

Obviously too few data are available on the effect of removal of the Harderian or lacrimal glands alone. However, the increase in mitosis was so definite and consistent in the larger first group in which both glands were removed that the data from the other cases of Harderian gland removal evidently do not fit with them. On the contrary, data from the experiment on extirpation of the lacrimal gland do agree with those of the first group, suggesting that the elevation in the number of mitotic figures found when both glands were removed was probably due to the removal of the lacrimal gland.

B. Corneal burns

Standard thermal burns were inflicted on both eyes of 18 rats from which the right Harderian and lacrimal glands had been removed. Ablation of the extraocular glands did not significantly (average +24.5 percent) affect the number of mitotic figures found in the regenerating epithelium. In only eight of the 18 cases were more mitoses found in the tearless cornea than in the control eyes, and this difference was great in only three cases.

Although mitosis in the regenerating epithelium did not appear to be affected by removal of the tear glands, the rate of epithelization was markedly increased. Healing was more rapid in the absence of these glands in 13 of the 16 cases in which it was measured. It was equally rapid in one case, and less than the control eye in only two cases.

The corneal burns of the operated eyes averaged one fifth of the area of the control burns at the 12-hour stage of healing. The data minimize the speed of healing in the tearless eye, because healing was so rapid that it had been completed in 10 of the 16 cases when the measurements were made, and thus do not show how much earlier that had been accomplished.

Since these results, although consistent, were unexpected, a second series of 19 rats, similar to the first, was prepared and corneal burns inflicted as before. In 17 of the 19 animals of this series, the burns of the operated eye healed more rapidly than those of the normal cornea. The remaining two cases healed at an equal rate. The unhealed area of the burns of the tearless cornea was 25 percent that of the burn on the normal cornea, similar to the first experiment in which it was 20 percent at the 12-hour stage.

Again these results are conservative because in five of the 19 cases the burns of the operated eyes had completely healed by 12 hours, whereas none of the control burns were covered by epithelium in this time. Since the data of these two experiments were so nearly identical, they were combined and are illustrated in Figure 2.

In order to determine whether the effects observed were due to the action of the Harderian or of the lacrimal gland, two additional groups of animals were prepared. In the first, Harder's gland was removed from the right orbit of 23 rats and the lacrimal gland not touched. The second group consisted of 22 rats in which the lacrimal gland

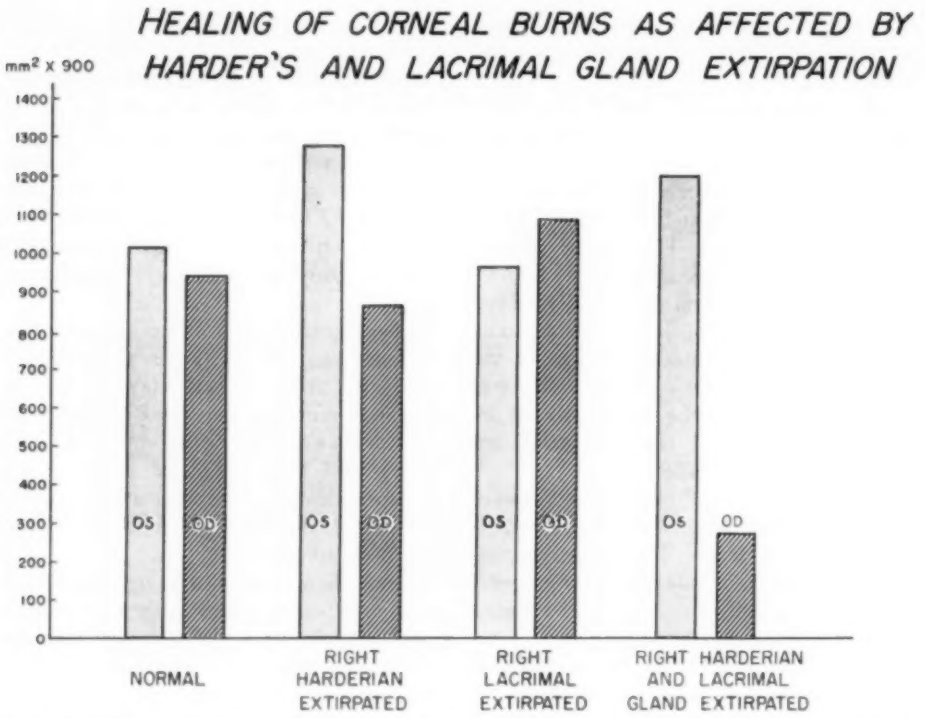

Fig. 2 (Smelser and Ozanics). The area of the unhealed portion of standard burns, at the 12-hour stage, is shown as measured on camera lucida drawings made at ×30 magnification. Identical burns were made on both corneas. The lacrimal and Harderian glands were intact in the left but removed from the right orbit. Both orbits were intact in the normal group which show the normal variation between the right and left eye.

had been removed from the right orbit, but Harder's gland was intact. Corneal burns were inflicted as before.

The number of mitotic figures in the regenerating epithelia was not significantly affected by removal of either gland. Extirpation of the Harderian gland did not have as pronounced an effect on the rate of healing of corneal burns as did removal of both glands, although the burns of two thirds of the cases healed more rapidly in the absence of Harderian secretion.

The area of the unhealed portion of the burn on corneas lacking Harderian secretion was 68 percent that of the area of control burns at the 12-hour stage (fig. 2), compared with 20 percent and 25 percent found in the first experiments. The favorable effect on healing of the corneal injuries was thus far less marked than in the series in which both glands had been removed.

Ablation of the lacrimal gland resulted in the loss of luster of the cornea noted in the original experiments in which both glands were removed. In general there was no effect on mitosis, although a definite reduction in the number of figures found occurred in a few cases. The speed of regeneration of the epithelium was not significantly affected by the absence of lacrimal secretion; the difference between the areas of control and experimental burns averaged only 12 percent (fig. 2). The corneal burns healed more rapidly in the operated eye in just one half

of the cases, indicating again a complete lack of influence of the lacrimal secretions on this process.

An additional attempt was made to determine whether extracts of these glands affect epithelial regeneration differently. Bilateral corneal burns were inflicted in a series of eight rats with intact ocular glands. The burns were treated with either rat Harderian or lacrimal gland extracts, made by grinding them with sterile sand and a minimum of physiologic saline. The two preparations were centrifuged and the supernatant material put in the freezing compartment of the refrigerator overnight. The lacrimal preparation was instilled into the left and the Harderian into the right eyes at 70-minute intervals.

Seven treatments were made and the animals autopsied 10 hours after the burns had been inflicted. The average area of the burns treated with Harder's gland suspension was 26 percent greater than in those receiving the lacrimal preparation, but the individual variation in response was great and the difference is not regarded as significant.

Discussion

Ablation of the tear glands of rats had three obvious effects on the cornea: (1) Loss of luster, (2) elevation of the number of mitotic figures in the intact cornea, and (3) a marked increase in the rate of epithelization following thermal burns.

The cause of the loss of luster is not clear. It occurs following removal of the lacrimal but not of the Harderian gland, both of which presumably secrete some fluid. Therefore, the dull cornea probably does not result from drying but possibly because of some qualities present in the secretion of the lacrimal gland but absent in the Harderian.

The increase in the number of mitoses in the uninjured epithelium following removal of these glands was associated with the lack of luster, and therefore with the deprivation in lacrimal-gland secretion. Possibly the loss of luster is due to a roughened corneal surface caused by rapid shedding of the surface cells. The increase in mitosis may represent an effort to compensate for such a loss.

The very rapid rate of healing of corneal burns made on eyes deprived of their secretions was surprising, particularly because, in a large series of experiments, no way had been found to increase the healing rate other than by the removal of obvious obstacles in the way of the normal process —that is, infection, malnutrition, foreign materials, and so forth.[5-8]

The increase in speed of healing could result from the more rapid movement of epithelial cells into and over the injured burn area, or by a shortening of the latency period which occurs before cell movement begins, though which of these conditions obtained was not determined. Since removal of the lacrimal alone had no significant effect, and of the Harderian alone much less than that which occurred when both glands were extirpated, a kind of synergistic effect of the two is indicated. The nature of this synergism is not clear.

In other experiments, it has been found that instillation of isotonic saline, buffers, oils, ointment bases, and so forth[5,7] slightly retard healing, which suggests that the lacrimal secretions may delay healing either mechanically or by solution of some needed materials from the regenerating epithelium. If this is so, the secretion of the Harderian gland must be a much more efficient solvent of this hypothetical material than the serous secretion of the lacrimal gland.

The volume of the tears is reduced (possibly not equally) in both experiments whether the Harderian or the lacrimal gland is removed. Mere reduction in volume of tears does not, therefore, seem to be important.

A second explanation could suggest that the Harderian secretion contains some substance(s) harmful to healing, in a manner

analogous to those found by Heerema and Friedenwald in lanolin.[8]

The experiment in which Harderian gland extract was instilled into the burned eye did not support this idea. However, instillation at hourly intervals cannot be compared with continuous secretion, nor can crude extracts of the gland compare with its normal secretion product. Such hypothetical toxic substance(s) might be extremely labile, or present in the gland in low concentrations.

Results

1. The number of mitotic figures is markedly increased in the corneal epithelium of rats following removal of the Harderian and lacrimal glands. Removal of Harder's gland alone did not affect the number of mitoses, but extirpation of the lacrimal gland was followed by an increase in the number of mitotic figures in the intact corneal epithelium.

2. When the corneal epithelium of eyes lacking both tear glands is burned, the rate of epithelization is greatly increased, but the number of mitotic figures occurring in the regenerating epithelium is not significantly augmented.

3. Removal of the lacrimal gland alone did not affect the speed of epithelization; however, extirpation of Harder's gland alone shortened the healing time of corneal burns. The effect of the latter operation was less than that obtained when both glands were removed.

4. Topical application of homologous extracts of either of these glands did not affect the epithelization rate of regenerating corneal epithelium.

5. The normal luster of the cornea is lost following the removal of the lacrimal, but not as a result of the Harderian gland extirpation.

630 West 168th Street (32).

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Ophthalmic Miniature

The continuance of east winds, not merely during the spring, but on many occasions far into the summer, is a frequent cause of ophthalmic affections, affecting the external tissues of the eye. To the same condition of climate may be attributed the frequency of rheumatic affections, which very often attack the internal structures of the eye.

W. R. Wilde,
London Journal of Medicine, 1851.

ETIOLOGIC CONSIDERATIONS OF VERTICAL MUSCLE DEFECTS*

Part II. Infranuclear vertical defects: Conclusion

Walter H. Fink, M.D.
Minneapolis, Minnesota

Infranuclear vertical defects

An infranuclear vertical deviation may be caused by paralysis or paresis due to a disturbance in innervation (motor nucleus or peripheral nerve) of one or more ocular muscles, an abnormal state of the muscle structure, an abnormal mechanical relationship of the origin or insertion of the muscle, or an abnormal relationship of the fascia (including check ligaments) due to maldevelopment or to a mechanical factor such as trauma.

These defects create a definite mechanical obstacle to binocular unity and are a basic cause of vertical imbalance. These mechanical factors are probably much more common than is generally recognized.

Major defects are readily recognized because of the binocular problem which is usually present. Slight defects are frequently not evident and are discovered only on careful examination. However, minor defects are of considerable importance because they may be a factor in the development of squint at a later date, if for some reason binocularity fails to function.

As in the case of supranuclear defects, the etiologic basis for infranuclear defects is not clearly defined in many instances. Very little pathologic proof is available, and most of our clinical data are based on inference.

In some the cause may be evident, in others the defect may be due to two or more factors some of which are not known, and in other instances the designated causative factor may be pure supposition. In most instances, more than one causative factor exists, and both supra and infranuclear defects may be present. In many cases secondary causative factors develop because of the presence of the primary defect.

Distinguishing characteristics of infranuclear vertical involvement

1. When the motor nuclei are affected, the resulting deviations will relate to the actions of individual muscles and will therefore be noncomitant in type. (It is possible, however, that the involvement may be primarily supranuclear but involve the nerve tracts which lie close to the motor nuclei, and therefore cause the defect to be noncomitant.)

In infranuclear involvement a vertical deviation which is usually present in the primary position increases or decreases in different parts of the field of fixation depending on the muscle involved. Because of this fact the version test, in which binocular movements are tested, is of great value in identifying the lesion.

(It is important to remember in this connection that the deviation is not due to actual weakness of the muscle, because only a small proportion of the power of a muscle is required to move the eye, but to an unequal distribution of power in the neuromuscular mechanism. Since the muscle exerts only a small part of its total power to rotate the eyeball as far as the checks permit, a muscle may be definitely paretic and yet not show it by a limitation of monocular rotation in any direction.)

Since the innervation of the two eyes is equal, the binocular rotations show any involvement at once: by the lagging of the involved eye when the normal eye fixes, and still more by the excessive rotation of the normal eye when the involved eye fixes (secondary deviation of the normal eye).

* Presented at the 88th annual meeting of the American Ophthalmological Society, Hot Springs, Virginia, June, 1952. Part I of this paper appeared in The Journal, October, 1953, pages 1427 to 1442.

Confusion in interpretation of the findings may result because a noncomitant deviation does not always retain its typical features indefinitely. The involved muscle may regain its function partially or completely without a decrease of the deviation, because, while the muscle is recovering, a contracture of the antagonist of the involved muscle takes place.

If that contracture is due to an increased tonus, it will gradually decrease and finally disappear if the pathologic origin is removed. However, the functional contracture may be transformed into an organic one, upon a change in muscular structure. In either case, the deviation maintained by a temporary functional or a permanent organic contracture will show characteristics suggesting a concomitant squint, the origin of which is no longer evident.

These secondary changes are seen in vertical deviations which begin in early life. The primary deviation arises congenitally as a developmental anomaly, as a result of trauma at birth or of disease in the first few months of life.

2. In addition to the noncomitant nature of infranuclear lesions, the uniformity or consistency of the angle of the deviation is of value in identifying the defect. The more consistent the angle of squint the more likely that the deviation is an infranuclear defect.

Unsteadiness of the angle of squint points to abnormal innervations of supranuclear origin as the essential etiologic factor. Such abnormal innervations may be intermittent. Even if the spasms are relatively the same, there will never be a constancy comparable to the steadiness of deviations based solely on mechanical factors.

3. Additional proof that the anomalous position of rest is based on infranuclear conditions may be obtained by excluding, as far as possible, those innervations which may affect the position of the eyes relative to each other; for instance, by correcting any existing hyperopia and suspending the influence of the fusion apparatus.

Also the change in the deviation when the patient is under anesthesia is suggestive. An esotropia which disappears entirely under general anesthesia indicates a supranuclear factor. The esotropia which changes little, if at all, under the same conditions is largely mechanical. An esotropia which is decreased but still present is partly supranuclear and partly mechanical, and the decrease is attributable to the elimination of the supranuclear portion under general anesthesia.

Etiologic classification of infranuclear defects

The etiology of infranuclear vertical defects may, for the purpose of simplification, be considered in two phases, namely: innervational defects, which include disturbances of the nerve impulses of the motor nuclei or their peripheral nerves; noninnervational defects, which include disturbances of the peripheral mechanism (orbit, globe, muscles, and fascia).

Such a division seems logical because of the different nature of the etiologic factors in the respective groups. Also, the embryologic development of the innervation element is independent of the peripheral mechanism, tending to create a different etiologic basis.

Innervational defects. Paralysis or paresis of a vertical muscle is an undercontraction of the muscle due to defective innervation. The abnormality may result from a lesion situated anywhere in the course of the nerve tract, from its nucleus to its termination in the muscle itself.

A certain number of vertical defects are of paralytic origin; in some instances this origin is evident, but in the majority of cases the evidence of paralysis is not conclusive. Some authorities consider most cases of nonaccommodative strabismus as paralytic in origin and in discussions of the defects of the vertical muscle there is a tendency to consider them paretic. However, such a conclusion is not substantiated by the evidence.

The words "paresis" and "paralysis" infer

that the basic cause for the abnormal action is a nerve involvement. As these terms are rarely based upon actual knowledge of a defect in innervation, they convey an erroneous impression. In referring to restricted action of an ocular muscle, the term "underaction" expresses the situation more correctly. It is preferable in the absence of exact knowledge that the cause is actually an involvement of the nerve to the affected muscle.

Attention should also be called to so-called "apparent paresis." Certain anatomic anomalies prevent adequate relaxation of the muscle with which they are associated when the direct antagonist of that muscle contracts; they produce an apparent weakness of the antagonist, when in fact the fault lies with the agonist.

Paralysis or paresis of the innervation to the vertical muscles (third and fourth nerves) may be classified on an anatomic basis as intracranial or orbital, depending upon the site of the lesion.

Intracranial lesions may be nuclear, fascicular, basal.

Nuclear lesions. The nuclei of the third and fourth nerves are situated in the floor of the fourth ventricle.

Nuclear lesions may be bilateral because fibers go from each basal nucleus to the muscles of both eyes, and a lesion of the nucleus, even though unilateral, may affect the muscles of both eyes. This is possible because of the following anatomic facts: the close association of the nucleus of the third nerve with the nucleus of the fourth nerve; the representation of some muscles on both sides of the brain; the representation of some muscles on the same side of the brain only, and of others on the opposite side of the brain only; the interconnection of the nuclei of the two sides by transverse fibers crossing the sagittal plane; and the interconnection on the same side by the posterior longitudinal bundles.

These points explain why a nuclear paralysis is almost always bilateral, why the affection is almost always of several muscles, and why bilateral total paralysis is typical of a nuclear lesion but unilateral total paralysis is rarely nuclear.

Conditions affecting the third and fourth motor nerve nuclei may be classified as:

1. Congenital aplasia of the nucleus may be a causative factor. Congenital lesions rarely involve the entire third nerve. Selective paresis of the levator and superior rectus muscles, either singly or together, is reported fairly frequently. Palsies of the inferior rectus, inferior oblique, or medial rectus rarely occur as isolated congenital phenomena. It is difficult to explain why, of several muscles supplied by the third nerve, the superior rectus muscle should be singled out for paralysis as frequently as has been claimed. It is also difficult to understand why superior rectus paralysis is not more often accompanied by ptosis. It is possible that a slight hemorrhage into the substance of a nucleus can be responsible for a selective paralysis even limited to certain fibers of a single muscle.

2. Vascular disease may cause hemorrhage into or adjacent to the nuclei and produce paralysis.

3. Neoplasms are usually found in an adjacent structure and may produce secondary effects on the nuclei.

4. Inflammatory processes may be acute nuclear ophthalmoplegia occurring in poisoning and intoxications (alcohol, lead, botulism, and carbon monoxide poisoning), as well as in the toxemias of diphtheria, measles, influenza. Acute ophthalmoplegia may result from anterior poliomyelitis and the polioencephalitis of alcoholic adults. Encephalitis lethargica affects the nuclei at any age.

The chronic nuclear ophthalmoplegias typically exhibit a gradual extension from one muscle to another. These more localized, chronic, and slowly progressive lesions are caused by tabes, general paralysis of the insane, progressive muscular atrophy, disseminated sclerosis, and sometimes syphilis in its earlier stages.

5. Trauma resulting from hemorrhage, as at birth, is a factor in a certain percentage of instances.

Fascicular paralyses. These are due to lesions of the fibers between their point of departure from the nerve nuclei and their emergence at the base of the brain where they unite to form the nerve trunks.

Incomplete but symmetric involvement of both nerves occurs with a variety of lesions in this portion of the brain. Owing to the close proximity of the nerve roots to the pyramidal tract and the facial nerve, these may be affected by the same lesion. A variety of combinations is possible, such as an involvement of a motor nerve with paralysis of the face on the same side and paralysis of the body on the opposite side.

Lesions at the base of the brain. The very short intracranial course of the third and fourth cranial nerves explains their comparative freedom from involvement in basal affections.

1. Most cases of periodic paralysis of the eye muscles are of basal origin.

2. Basal lesions may affect one or several muscles, and not infrequently both sides at once.

3. The lesion may develop as a primary affection in the nerve or adjacent areas. Much more frequently, however, the structure suffers indirectly as a result of disorder in the vicinity.

4. Inflammatory processes are a causative factor in this region. Syphilitic and tuberculous meningitis are especially apt to produce third and fourth nerve paralysis because of the tendency of the process to localize between the chiasm, pons, and temporal lobes, where the nerves emerge from the brain stem. Unilateral ophthalmoplegia occasionally originates in a lesion of the trunk of the nerve at the base of the brain. Bilateral ophthalmoplegia indicates a widespread involvement in the brain stem or in a region where the nerves come into close association outside the brain, as in the cavernous sinus.

5. Peripheral neuritis may result from alcohol poisoning and lead poisoning.

6. Arteriosclerosis may affect a motor trunk, either by the pressure of a thickened artery upon a nerve or by similar pressure exerted by intracranial aneurysms.

7. Neoplasm may cause pressure on the nerve. This may be a nasopharyngeal tumor or a tumor in the neighborhood of or connected with the pituitary body.

8. Fracture of the base of the skull may cause an immediate paralysis of motor nerves or they may be involved in a delayed paralysis due to an extravasation of blood. Delayed paralysis may also supervene from infection after some days.

9. Defective development of the nerve is rare.

Orbital paralyses are those in which the lesion is situated in the nerve trunk, after the entrance of the nerve into the orbit. The causes of orbital paralyses may be tumors, injuries, or inflammation of the orbit or its vicinity, such as accessory sinuses of the nose. In the majority of these cases the cause is not evident.

1. Polyneuritis from a variety of toxins (alcohol, lead, arsenic, carbon monoxide, and those of diabetes) may involve the third and fourth nerves in this region as it does any peripheral nerve.

2. Trauma to the orbit is a frequent cause of paralysis. Trauma at birth, involving the third and fourth nerves in this region, is considered a relatively frequent cause of squint. Injuries are particularly likely during protracted labor, especially if the trauma of forceps is added to that of prolonged compression of the head. Orbital injury or prolonged compression of the skull may damage both muscles and nerves. Occasionally the damage is severe, causing paralysis of several muscles; but ordinarily the injury is slight. Blows to the orbit are also common causes; paralysis of the superior oblique is frequently seen as a result of boxing or fighting. Other causes are radical frontal and ethmoid operations. Paralysis of the in-

ferior oblique is very rarely the result of the usual forms of trauma. However, it may be injured during operations for retinal detachment or during a recession of the lateral rectus (more likely if the lateral muscle is reoperated).

NONINNERVATIONAL FACTORS. The vertical defects in this group are due to peripheral factors which produce a disproportion between the action of one or more muscles and their antagonists. Many vertical defects are thought to be due to anatomic anomalies. Scobee[9] states that in 90 percent of all patients with heterotropia which develops before the age of six years there is some underlying anatomic anomaly. The anatomic anomalies may not in themselves be sufficient to produce heterotropia but when other factors (such as excessive accommodation) are superimposed, they act to precipitate the heterotropia.

The nature of the embryologic development of the peripheral structures is such that developmental anomalies are likely to occur.

The extrinsic muscles and fascia of the eye are developed from a continuous mesodermal sheet; a defective cleavage and maturation in this developing mesoderm may result in motor anomalies.

The oculomotor muscles represent a complete maturation of the developing mesoderm; the fascia which develops from arrested development and variations in development may occur, the same mesoderm represents a less complete development. Both including all degrees of failure of differentiation, from grossly abnormal fascial fusions and formations or abnormal muscle formations to minor fascial or muscle anomalies.

Granting the frequent occurrence of other factors it is the impression of the author that a certain percentage of vertical muscle imbalances are due basically to a disturbance of the peripheral mechanism. In many of these cases the causative factor is a mechanical defect resulting from faulty anatomic relationship, such as malformation involving the orbit and orbital contents (extrinsic muscles, eyeball, fascial developments).

Some of these anomalies are probably particularly associated with variations in the fascial sheath or the tendinous insertion of the muscle. This opinion is based on observation in the operating room and in the dissecting laboratory, where maldevelopment of this kind has been encountered.

Such a mechanical defect in a vertical muscle will cause the muscle to underact, so that findings at examination may simulate a paresis of the muscle. If the effect of the defect is slight, the result is only heterophoria. If the effect is greater, the tendency toward heterotropia results: some other factor—accommodative, innervational—may precipitate the heterotropia.

It is generally agreed that innervational impulses neutralize the effect of a high percentage of such abnormal mechanical situations. However, there is a limit to the adjustment capacity of the binocular mechanism. When taxed beyond its capacity, deviation results.

To simplify the presentation, the noninnervational factors causing vertical defects may be grouped into the following categories:

Defects related to the eyeball;
Defects related to the orbit;
Defects related to the fascia;
Defects related to the muscles.

Defects related to the eyeball are etiologic factors chiefly in horizontal defects and are not as a rule primary factors in vertical defects. As they influence the vertical mechanism to only a limited degree or as secondary factors, they will be briefly considered.

Refractive obstructions. High refractive errors, anisometropia and aniseikonia, can result in a disruption of the normal synergy between accommodation and convergence. As such disruption affects the horizontal mechanism for the most part, these obstructions relate to our present interest only indirectly.

Ocular obstacles include cases with some organic obstacle to fusion—developmental or

pathologic. Such factors are especially important throughout the years of childhood, especially during the early years.

Developmental obstacles prevent an adequate establishment of binocular vision during the period when the binocular reflexes are normally conditioned. Pathologic obstacles affect the formation of clear images, especially if the opacities are unilateral or unequal on the two sides. Pathologic conditions may be the result of trauma or of diseases which cause opacities in the cornea, lens, and vitreous. Certain retinal and choroidal lesions may also be included in this group. These conditions likewise influence the vertical mechanism indirectly and are not as a rule the primary factor in a vertical defect.

External obstacles. Dim illumination and prolonged uniocular activity (due to such factors as incorrect spectacles, covering one eye, and so forth) are contributing factors.

DEFECTS RELATED TO THE ORBIT. The topographical relationships between the eyeballs and their adnexa are of importance in determining the position of the eyes and the freedom of their movements. Positional obstacles may be: *developmental,* due to anomalies in the symmetry and inclination of the orbits and the shape of the skull, or to abnormalities in the shape of the globes themselves (particularly in high myopia) and their position (as in proptosis); caused by *disease* (inflammatory, neoplastic) displacing the eye; caused by orbital *injury* resulting in damage to the tissues which support the eyeball, or to organization of blood clot interfering with the action of the muscles.

All these obstacles may considerably impede the free excursion of the eyes and disorientate the pull of the muscles so that binocular action is impossible, ocular imbalance is produced, and, in the more extreme degrees, a directional limitation of movement or complete exophthalmoplegia.

It is important to remember in discussing this group of causative factors that, as long as fusion is normal, an imbalance may not exist even with a definite difference in the level of the orbits or other factors tending to create lack of alignment of the eyeballs. This is especially true in cases where reflexes are developed in this state and are normal. However, if one eyeball becomes higher than the other in the course of some disease or trauma, after the reflexes have become firmly fixed, an entirely different situation exists. A disturbance may be of sufficient degree to disrupt the firmly fixed reflexes and create an insurmountable obstacle to binocular vision.

DEFECTS RELATED TO THE FASCIA which surround the extrinsic muscles may cause a mechanical defect and produce a vertical deviation. If the defect is slight, the patient may pass through the critical fusion-development stage and the resultant deviation tendency is then kept latent as a phoria.

Fascial abnormalities may be acquired or developmental.

The acquired fascial defects may result from scar tissue formation following injury, inflammation, or a deviation of long standing. An eye deflected for many years may acquire fascial contractions conforming to the fixed position of the globe. A check ligament not called on to perform its function for a number of years may lose some of its elasticity and thus act as an obstacle to outward rotation. Some question the importance of the time factor in the development of abnormal check ligaments, because the same anomalies are found in the two-year-old and in the 30-year-old with esotropia.

In *developmental fascial defects* the anomalies precede the tropia in point of time and the tropia is at least partly due to the anomaly.

Abnormal development of the fascial covering of the vertical muscles and the check ligaments is believed by some to be more common than the textbooks indicate, exerting a definite influence on the action of the binocular apparatus. A series of dissections will demonstrate marked variation in the fascial development.

Anomalous fascial formations may be explained on the basis of incomplete maturation of the mesoblastic tissue. As mentioned previously both muscle and fascial tissues originate from the same mesoblastic tissue; muscle tissue represents a full maturation of the mesoderm; the fascia which surrounds the muscle and tendon represents mesoderm which did not proceed to that full degree of differentiation. A variation from its usual degree of maturation might possibly produce an abnormal fascial development. This abnormal development could influence the normal action of the muscle by producing, for example, a defective check action.

Scobee,[9] in his description of abnormal fascial conditions and how they affect muscle action, points out that certain types of muscle imbalance can be attributed to abnormal fascial development. He found in esotropia the following variations from normal fascial development existing either separately or in combination:

1. Extra and thickened check ligaments. The normal main horizontal ligament is present, quite obviously thickened and somewhat contracted. Extra check ligaments arise from a line paralleling the origin of the main ligament, either just above or just below it.

2. Fused check ligaments. Three or five ligaments are apparently fused together into a thick solid mass running from the muscle sheath to the orbital wall.

3. Posterior check ligament. A posterior check ligament arises from the muscle sheath far back in the orbit and runs anteriorly, inserting into the medial orbital wall along its entire course.

One or more of the anomalies just listed was found by Scobee in more than 52 percent of all horizontal tropias which had appeared before the age of six years and which were known not to be due to trauma or systemic disease.

The existence of any one or all three abnormal fascial developments, Scobee believes, will prevent proper abduction of the globe with a muscle hook under general anesthesia, and may cause retraction of the eyeball if abduction is forced.

Scobee believes these anomalies act as an obstacle to easy and prolonged convergence, by preventing adequate relaxation of the lateral rectus muscle during the act, and play a predisposing role in many cases of strabismus. Convergence is probably normal but prevented from attaining a normal range because of mechanical obstacles.

If the effect of the anomaly is slight, only heterophoria results; as the effect of the anomaly becomes greater, a predisposition toward heterotropia is created and any other factor—such as accommodative or innervational—may precipitate it. It is only in strabismus fixus that the anomaly may be considered the sole cause for the deviation.

Although Scobee's work emphasizes the fascial abnormalities of the horizontal muscles, it is possible that overaction and underaction of the vertical muscles can be explained on the same basis. A study of the complex anatomy of this area suggests the feasibility of such an explanation.

That fascial anomalies are the cause of abnormal action of the *superior oblique* is a debatable point; we have very little definite evidence to substantiate such a claim. An abnormal fascial development or check action is difficult to demonstrate during operation on the superior oblique; it is also difficult to demonstrate in a dissection because of postmortem changes. It is, of course, conceivable that such anomalies exist, but the degree to which they influence the action of the muscle can only be surmised.

I have encountered cases in which the fascial membranes surrounding the superior oblique tendon showed definite evidence of contraction and caused a disturbance in the action of the muscle. In some instances, the cases were associated with a marked underaction of the inferior oblique and, as described by Brown[10] in his presentation of the superior oblique sheath syndrome, may have been secondary to a defective inferior oblique. However, in these cases the inferior

oblique muscle seemed structurally normal, and the sheath of the superior oblique was congenitally short (because of a lack of force during its development).

In other cases a mechanical factor—for example, direct or indirect trauma such as results from surgery on an adjacent tissue—disrupts the fascial relationship. Thus, a recession of the superior rectus can cause adhesions which interfere with the action of the adjacent tendon of the superior oblique. Likewise, extensive resection or recession of the medial rectus can interfere with the fascial sheath of the adjacent superior oblique.

In the case of the *inferior oblique* we have more evidence of abnormal fascial formation, both at surgery and in the dissecting room. I have observed during operation thickened fascial bands which unite the inferior oblique and lateral rectus sheaths more intimately than usual.

A series of dissections will demonstrate marked variation in the fascial development at the point of crossing of the inferior rectus and inferior oblique, with variable degrees of fusion; such variations in fascial formation might well have definite clinical significance. Also, trauma resulting from injury to the muscle or surgery on the lateral or inferior rectus sometimes creates scar tissue which may constrict the action of the inferior oblique.

Spastic overaction of the inferior oblique is seen frequently. Although various explanations have been given for an overacting inferior oblique, a weakened check action due to abnormal fascial development may be considered a possible cause as it could prevent restricting influence on the contracting inferior oblique.

Like the obliques, the *vertical recti* can be inhibited in their normal action by abnormal fascial conditions, either acquired or developmental. The acquired defects may result from trauma, such as a blow or perforating injury, or from scar formation following surgery on these muscles.

Developmental defects of the fascial coverings and check ligaments account for some of the abnormal action of these muscles. Like the obliques, these muscles are inaccessible, and, because of their complex fascial coverings, it is difficult to recognize abnormal developmental states.

Certain evidence, however, demonstrates their presence. For example, the so-called "vertical retraction syndrome" mentioned by Brown[10] is an example of a congenital maldevelopment involving the vertical recti.

Brown considers the condition due to congenitally paralytic superior and inferior rectus muscles of the same eye, and suggests the presence of limiting fibrous bands in the vertical recti. Of the 10 or 12 cases that Brown has observed, all but one showed retraction movement on elevation only. In this case the inferior rectus was more paretic than the superior rectus, and the retraction occurred only in depression in the temporal field.

Brown states that the retraction movements in this anomaly are not so evident as those in the retraction syndrome, but on maximum effort of monocular elevation of the affected eye in the temporal field there is a definite retraction with some narrowing of the palpebral fissure.

Defects related to the muscle are important. They may be nondevelopmental or developmental in origin.

NONDEVELOPMENTAL DEFECTS. *Trauma to a muscle.* Usually the injury is slight, such as rupture of the sheath or a hemorrhage into the body of a muscle, leading to little or no damage. At times it may be pronounced and produce permanent fibrosis.

Myasthenia gravis. The paralysis may involve various eye muscles, although the intraocular muscles always remain exempt. Characteristic of these paralyses is a rapid increase upon exhaustion. The diagnosis is established if there is associated feebleness of muscles of the face, neck, and masticatory apparatus. The prostigmine test is of value.

Hereditary ophthalmoplegia externa. This

condition, which may not become obvious until adult life, has been explained as an abiotrophy of the muscle fibers concerned.

Tumor. A neoplasm may originate in a muscle, for instance, a fibrosarcoma; or the muscle may become involved by malignant metastases.

DEVELOPMENTAL DEFECTS. Defects of congenital or developmental origin are important because defective cleavage of the mesodermal sheet from which the muscles develop is probably much more common than the literature would indicate. Minor anomalies which can be compensated by the corrective fusion reflexes (abnormal insertion or weakness of a muscle) probably cause some cases of heterophoria; greater degrees which cannot be thus compensated lead to a squint in which there is incomitance.

As to frequency of ocular muscular anomalies, Whitnall[11] states, "It is probable, to judge from the writer's individual experience in finding quite a number of gross abnormalities of the ocular muscles in a series of dissections, that such are by no means as excessively rare as would appear from the number recorded in the literature; dissecting room conditions do not favor their identification, and in life some may be unrecognizable through compensatory action of the other muscles."

Clinically, anomalies are not frequently observed, although possibly often overlooked, as suggested by the frequency with which they are encountered in the dissecting room. Many cases of congenital squint are apparently dependent upon such anomalies, and it is only by an appreciation of this fact and a better knowledge of these peculiarities that the surgeon can anticipate the presence of an anomaly before operation.

Developmental anomalies of the muscle may be considered under the following heads: anomalies of the muscle; anomalies of the insertion; anomalies of the plane of action of the muscle.

DEVELOPMENTAL ANOMALIES OF THE MUSCLE. Absence of a vertical muscle: Judging from the number of cases reported, total absence of an oblique muscle is exceedingly rare. Posey[12] in 1923, in an excellent review of extrinsic muscle anomalies, cited but one instance in which the oblique muscles were reported absent (Harles, 1880). Duke-Elder[13] mentions Cazeau (1833), who reported the absence of both superior obliques. Undoubtedly other cases have been reported but were not encountered in a partial review of the literature.

Judging from the literature, absence of the other vertical muscles is more frequent. To cite a few of the reported cases: Casten[14] encountered congenital absence of the inferior rectus muscle and was able to find 10 other cases reported in the literature. McDannald described absence of the inferior rectus muscle (proved by operation). Posey reported the inferior rectus muscle absent except for a rudimentary portion at the usual site. Stieren described absence of one inferior rectus muscle, and Davis absence of both muscles.

Steinheim reported a case of absence of the superior rectus muscle. Natale reported a case of congenital strabismus in which both the superior rectus and inferior rectus muscle were found absent at operation. Coover, in operating on a woman in an attempt to advance what he thought were paralyzed superior and inferior rectus muscles, found them absent. Klincosch reported absence of all the ocular muscles.

Fibrosis. Muscles are frequently found to be relatively inelastic. A muscle that is constantly prevented from relaxing adequately may eventually become somewhat contracted and later slightly fibrotic. For example, the so-called overfunction of the inferior oblique may be a secondary contracture, following paralysis of the superior oblique of congenital or early origin.

The degree of fibrosis is highly variable. In some cases the muscle is practically replaced by a fibrous band (Duane's syndrome, where the squint is due to a contracture in a muscle).

Abnormal development of the vertical muscles: This condition is much more frequent than absence or fibrosis of a muscle.

Superior oblique muscle. The muscle may end at the trochlea, or a normal superior oblique may be accompanied between the eyeball and the pulley by an extramuscular slip which has a common insertion with it upon the eyeball.

The superior oblique may be closely accompanied by an offshoot from the levator palpebrae superioris, sometimes called comes obliqui superioris. In a specimen of Whitnall's[11] there were two long muscle bundles, arising in common with the levator and ending anteriorly, the one upon the fascia bulbi between the superior oblique and the globe, the other on the orbital margin beneath the pulley; the nerve supply came from the fourth nerve; the superior oblique was broader than usual. He also described a slip passing from the medial border of the levator to the pulley of the superior oblique.

Ledouble[15] found supernumerary fasciculi accompanying the reflected tendon, and has further recorded a case where the direct or normal fleshy part of this muscle was absent, the reflected or usually tendinous part being muscular and arising from the site of the pulley, recalling the type normally found in nonmammalian vertebrates.

According to Prangen[16] two instances have been found in the human in which the superior oblique muscle ended in a common tendon with the terminal nasal fibers of the superior rectus muscle. This type of anomaly very likely is more frequent than reports in the literature indicate.

Inferior oblique muscle. Some variation in the point of origin of the muscle has been observed. As a rule, it is usually adjacent to, or rarely more than three mm. from, the incisura lacrimalis. The inferior oblique was found by Whitnall[11] to have an abnormally placed origin in the following number of 100 orbits examined by him:

The origin was in the usually described position immediately adjacent to the incisura lacrimals of the maxilla in 45 instances; from two to five mm. distant from the incisura lacrimalis of the maxilla in 47 cases (most often in the left orbit); and from six to seven mm. lateral to the normal position in eight cases. In three of the eight cases the muscles were found to be inserted higher than usual, in a position resembling that found in certain fishes; their total length was normal.

Remington[17] encountered one case in which the origin was at least five mm. lateral to its usual site. White described a two-headed origin—one origin was normally placed, while the other was several millimeters lateral to it. In the series of 25 specimens examined by the author, the position of the origin varied a few millimeters, but, as a whole, the point of origin conformed to the normal.

An abnormal muscle bundle (musculus obliquus accessorium inferior) is occasionally observed. Rex reported an abnormal muscle bundle passing from the apex of the orbit to the inferior oblique, also sending a slip to join the inferior rectus; the anomaly was found in both orbits and was supplied by the third nerve.

An important anomaly which involves both obliques is referred to as "voluntary propulsion of the globe."

The point of crossing of the inferior oblique and the inferior rectus shows considerable variation in the degree of fusion; some specimens are firmly, others loosely, fused. These fusions appear to be fundamentally fascial in character. Abnormal fusion at the point of insertion of the inferior oblique has been noted quite frequently. This is for the most part with the lateral rectus muscle and in some cases appears to be both fascial and muscular in character.

Vertical rectus muscles. A developmental tendency to anatomic abnormalities in the vertical recti is seen chiefly in the presence of supernumerary slips of muscle tissue. These abnormalities seem to be rare, but since they are difficult to find in the dissect-

ing room, it is possible that they occur more frequently than the literature would indicate.

Abnormal muscle slips may rise well back in the orbit and diverge slightly from the course of the muscle which is their apparent source to become inserted into the globe at a point somewhat behind and to one side of the insertion of their parent muscle; or be composed of an abnormally large collection of muscle fibers in the intermuscular membrane. The latter condition is by far the more common. Abnormal muscle slips appear in association with the rectus muscles in the following order of frequency: superior rectus, lateral rectus, medial rectus, and inferior rectus.

The above characteristics, representing but a portion of the literature, show that one, several, or all of the extraocular muscles may be involved in abnormal development. Also, it seems apparent that anomalies of the ocular motor muscles are more frequent than published reports would indicate.

Anomalies of the muscle insertion. Abnormal insertion of the vertical muscles is a mechanical etiologic factor which may exist in the peripheral mechanism.

Superior oblique. The insertion of the superior oblique tendon is the most variable of all extrinsic muscle insertions. This marked variability is dependent chiefly upon two factors, namely, the variable length of the superior oblique insertion and the variable angle of its insertion. In 100 specimens examined by the author the average length of the insertion was 11 mm. Seventy-three of these specimens showed an average length of 10.8 mm., with measurements ranging between 9 and 13 mm. Of the remaining 27 specimens, three were 7 mm., 10 were 8 mm., six were 14 mm., five were 15 mm., two were 17 mm., and one was 18 mm.

The length of insertion as measured by Fuchs[18] on 31 emmetropic globes averaged 10.7 mm., with extremes of 7.5 to 12.7 mm., but was shorter in myopic globes, in 20 of which it averaged 9.6 mm., with extremes of 6.8 to 14 mm.

In addition to this marked variation in the length of the insertion, the variable angle of insertion should be emphasized. Fuchs described two types of insertions: one in which the line is broad with a strongly marked anterior concavity, lying in an equatorial direction across the vertical meridian with the greater part on its lateral side, as more commonly found in emmetropic and hypermetropic eyes; the other narrower and flattened, and lying entirely in the lateral quadrant almost parallel to the vertical meridian, as found in myopic (though occasionally in normal) globes.

Inferior oblique. The insertion of the inferior oblique, though variable, is more uniform than that of the superior oblique. The variation consists chiefly in the degree of obliquity and convexity of the curve. The insertion often shows gross irregularities, such as angular serrations or dehiscences.

The line of insertion of the inferior oblique lies in the lateral and posterior portion of the eyeball under the lateral rectus. The line of insertion is oblique, with the convexity upward, and is for the most part below the horizontal meridian, with which it makes an angle varying from 15 to 20 degrees.

The length of insertion of the inferior oblique muscle in 100 specimens averaged 9.6 mm. In 93 cases the average was 9.5 mm., the measurements varying between 8 and 10 mm. Of the remaining cases one was 5 mm., one was 7 mm., two were 12 mm., and two were 14 mm.

Some believe that an insertional difference in the two obliques may account for overaction of the inferior oblique in adduction. While the inferior oblique is inserted at or near the equatorial level, the superior oblique is inserted medially and much above this level. This means that a considerable change in the direction of action of the latter muscle and scarcely any in that of the former occurs as the direction of gaze changes.

Vertical recti. Very little data are available concerning abnormal insertion of the

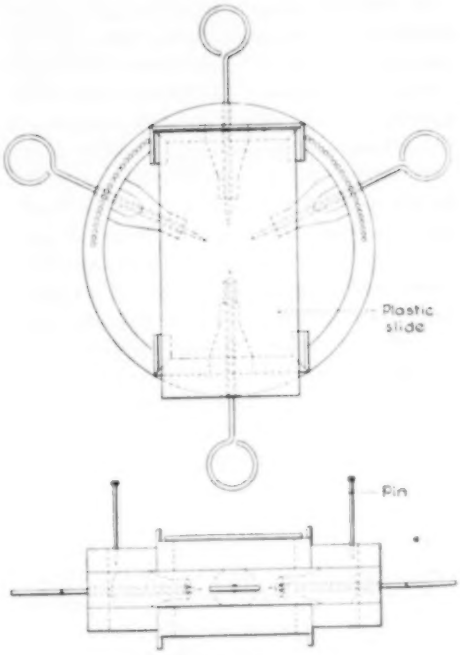

Fig. 1

Figs. 1 and 2 (Fink). *Apparatus used for measuring oblique muscle planes.*

The apparatus is constructed in such a way that the eyeball can be placed in it so that its anterior-posterior vertical plane is established. This is accomplished by placing four stabilizing pins in the eyeball, one in front passing through the center of the cornea, one posterior passing through the macular area, and one on each side at the junction of the geometric equator and the horizontal meridian of the globe. These four points stabilize the position of the globe and permit the establishment of the anterior-posterior vertical plane of the eyeball.

The angle which the tendon of the superior oblique makes with the anterior-posterior vertical plane of the globe is determined as follows:

A suture is attached to the severed end of the superior oblique tendon and the suture is fixed by a pin to the circular rim of the instrument in such a position that the tendon plane of action assumes its proper relation to the globe. The plane of action of the tendon is found by determining the direction of the tendon fibers in relation to the tendon insertion.

A plastic slide is placed over the specimen and the plane of action of the superior oblique and the anterior-posterior vertical plane of the globe are traced on the plastic cover. The slide is then removed from the instrument.

The plane of action of the inferior oblique in relation to the anterior-posterior vertical plane of the globe is determined in a similar manner. With the globe in position in the instrument, a suture is attached to the origin end of the cut muscle. The suture is attached to the rim of the instrument by a pin placed in a position which is determined by the plane of action of the muscle. The plane of the muscle in relation to the globe is found by determining the direction of the muscle fibers in relation to the insertion of the muscle. A plastic slide is placed over the eyeball and the plane of action of the inferior oblique muscle and the anterior-posterior vertical plane of the globe are traced on the slide.

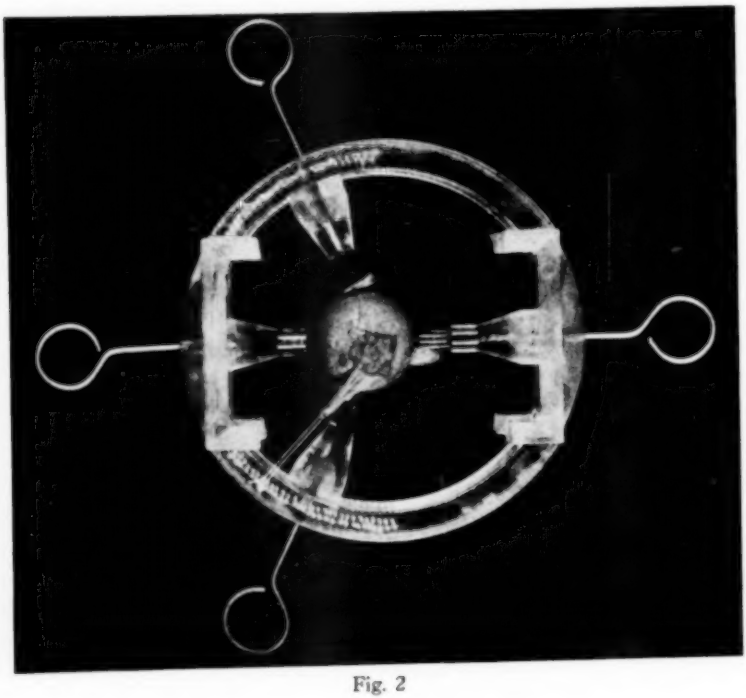

Fig. 2

The slides having the tracing of

vertical recti. In the author's experience there is less variability than in the insertion of the obliques. Undoubtedly, a certain amount of variation exists in the line of insertion, but insufficient data exist to make a positive statement.

Anomalies in the plane of action. Abnormal plane of action of a vertical muscle should be considered in discussing mechanical defects of the peripheral mechanism. Since, from the evidence at hand, this factor applies chiefly to the oblique muscles, the discussion will be confined to this aspect of the subject.

The abnormal planes of action of the obliques can be best appreciated by comparison with the normal planes. After passing through the trochlea, the superior oblique muscle turns downward, outward, and backward at an angle of about 54 degrees from its previous course, and becomes inserted into the posterolateral aspect of the globe, making a very small arc of scleral contact.

The inferior oblique muscle passes laterally backward and upward beneath the inferior rectus. After crossing the inferior rectus, it curves around the eyeball, making a large arc of scleral contact, then passes beneath the lower border of the lateral rectus to become inserted in the posterior lateral quadrant of the eyeball. The line of insertion is oblique and for the most part is below the horizontal meridian of the globe, with which it makes an angle varying from 15 to 20 degrees.

In a comparison based on 100 specimens the anterior tip of the insertion of the superior oblique averaged 0.4 mm. anterior to the equator of the globe; whereas the anterior tip of the inferior oblique insertion averaged 1.3 mm. posterior to the equator of the globe, a difference of about 2.0 mm.

Because the obliques are usually inserted in a different position on the globe, the oblique muscle planes do not coincide. However, most observers consider that, for practical purposes, the muscle planes should be regarded as the same, making an angle of about 51 degrees with the visual line, and that any mechanical difference in the plane of action is neutralized by the adjustment capacity of the central mechanism.

Undoubtedly, this is true in eyes in which slight deviation exists, but in cases of greater degree there is a question as to the validity of this assumption. In a series of specimens studied by the author, measurements of the relation of the two obliques varied sufficiently to cause him to question such a supposition. In 122 adult human specimens, measurements were made of the relation of the planes of action of the two obliques to one another, and of their relation to the anteroposterior vertical plane of the eyeball (figs. 1 and 2). The following data were found:

Average angle made by the oblique muscle planes with the anteroposterior vertical plane of the eye (based on the measurement of 122 specimens) was:

Superior oblique, 44.9 degrees (54 degrees usually accepted).

Inferior oblique, 45.5 degrees (52 degrees usually accepted; see fig. 3).

Average measurement of 22 specimens showing greatest variation in the angles which the oblique muscle planes make with the anteroposterior vertical plane of the eye was:

Superior oblique, 39.1 degrees.

Inferior oblique, 47.1 degrees.

Average measurements of the 100 remaining specimens which showed less variation in the angle which the oblique muscle planes make with the anteroposterior vertical plane of the eye were:

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the superior oblique plane are superimposed and so placed that the tracings of the anterior-posterior vertical plane of each slide coincide. The line indicating the planes of the two obliques and the line indicating the anterior-posterior plane of the globe are traced on a paper. The tracing obtained indicates the relation of the planes of action of the two obliques to each other and to the anterior-posterior plane of the globe and this relationship can be measured in degrees of angle.

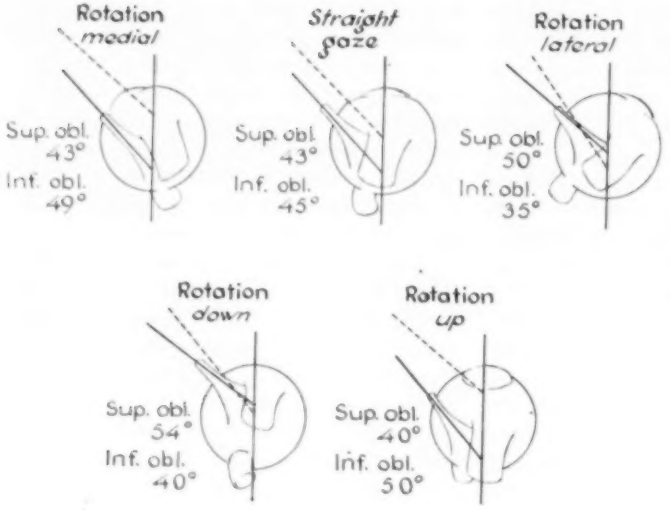

Fig. 3 (Fink). *Drawing of a specimen in which the relation of the planes of the obliques to each other and to the plane of the globe are average for the group.*

The drawing indicates the change in relation of the planes of the obliques to each other and to the anteroposterior vertical plane of the globe when the globe is rotated from the eyes-front position. Continuous line indicates plane of the superior oblique plane. Broken line indicates plane of the inferior oblique plane.

Superior oblique, 45.9 degrees.

Inferior oblique, 45 degrees.

Although the average angle which the planes of action of the superior and inferior obliques made with the anteroposterior vertical plane of the eye was about 45 degrees in this series, a study of individual specimens revealed in many instances an appreciable variation in the muscle plane of one oblique as compared with the other. They varied sufficiently from each other to raise a question as to a balanced action between the two muscles. It is apparent that other factors must act to compensate for the difference in the two planes of action in most instances of this type.

However, in higher degrees of variation, as found in some of the 22 specimens (figs. 7 and 8) showing greatest variation, it is possible that such a condition may create a mechanical obstacle to binocularity and, when associated with other etiologic factors, may be sufficient to produce a deviation.

The specimens showing greater variation could be divided into two main groups:

1. Some specimens showed a marked variation in the planes of action of the two obliques (fig. 4).

2. Other specimens showed almost similar angles with the anteroposterior vertical plane of the globe, but differed markedly because the oblique muscle planes were separated by several millimeters (fig. 5).

Measurements taken from individual specimens which showed the greatest variation of the angle of the oblique muscle planes showed the following:

Measurement of the specimen showing the greatest separation of the oblique muscle planes: Superior oblique, 57 degrees; inferior oblique, 35 degrees. (See fig. 6a.)

Measurements of the specimen showing greatest crossing angle of the two oblique muscle planes: Superior oblique, 35 degrees; inferior oblique, 70 degrees. (See fig. 6b.)

Measurements of the specimen showing the greatest difference in the angle of the oblique muscle planes as compared with the anteroposterior vertical plane of the eyeball:

When the superior oblique shows the greater angle: Superior oblique, 64 degrees; inferior oblique, 33 degrees. (See fig. 6c.)

When the inferior oblique shows the greater angle: Superior oblique, 32 degrees; inferior oblique, 57 degrees. (See fig. 6d.)

Measurements of the specimen showing

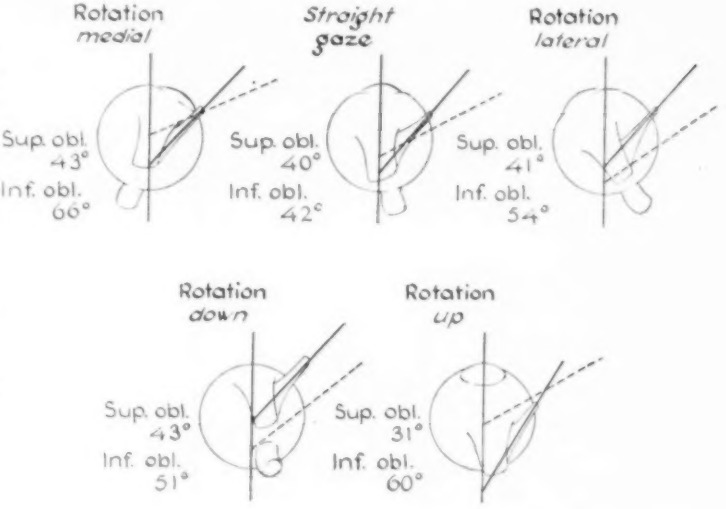

Fig. 4 (Fink). *Drawing of a specimen in which there was a crossing of the oblique planes.*

The change in relation of the muscle planes to each other and to the anterior-posterior vertical plane of the eye is shown when the eye is rotated from the eyes-front position. Continuous line indicates plane of the superior oblique plane. Broken line indicates plane of the inferior oblique plane.

the greatest angle of oblique planes with the anteroposterior vertical plane of the eyeball: Superior oblique, 67 degrees; inferior oblique, 60 degrees. (See fig. 6e.)

Measurements of the specimen showing the smallest angles of the oblique planes with the anteroposterior vertical plane of the eyeball:

Superior oblique, 22 degrees; inferior oblique, 34 degrees. (See fig. 6f.)

It seems to me that a congenital maldevelopment in the planes of action of the oblique muscles is as logical an explanation as any for certain abnormal actions of the vertical muscles. For example, take the case of the upshoot of the inferior oblique on adduction. That inherent lack of balance may exist between the opposing obliques is possible and can be explained on the following basis:

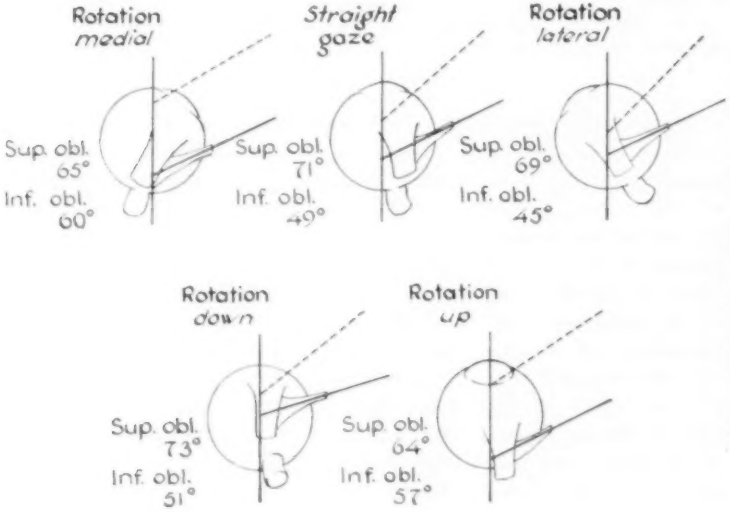

Fig. 5 (Fink). *Drawing of a specimen in which the planes of the two obliques are widely separated.*

The drawing indicates the change in the relation of the oblique planes to each other and to the anterior-posterior vertical plane of the globe when the eye is rotated from the eyes-front position. Continuous line indicates plane of the superior oblique plane. Broken line indicates plane of the inferior oblique plane.

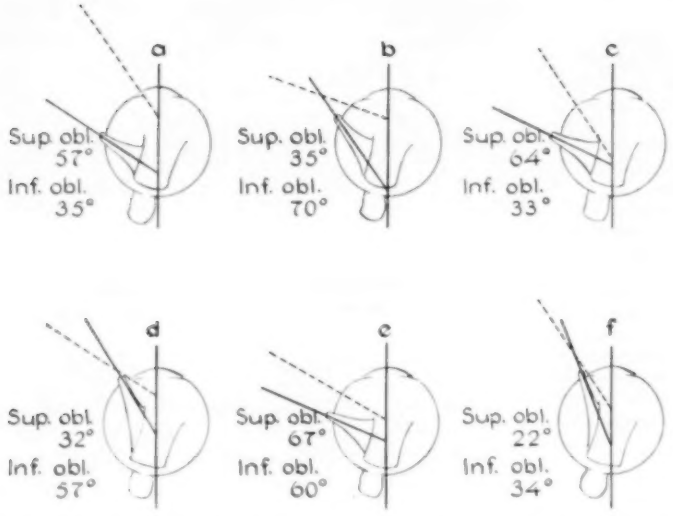

Fig. 6 (Fink). *Drawings of specimens in which there are pronounced variations of the oblique muscle planes of action.*

a. Measurements of the specimen showing the greatest separation of the oblique muscle planes: Superior oblique, 57 degrees; inferior oblique, 35 degrees.

b. Measurement of the specimen showing the greatest crossing angle of the two oblique muscle planes: Superior oblique, 35 degrees; inferior oblique, 70 degrees.

Measurement of the following specimens shows the greatest difference in angle of the oblique muscle planes as compared with the anteroposterior vertical plane of the eyeball:

c. When the superior oblique shows the greater angle: Superior oblique, 64 degrees; inferior oblique, 33 degrees.

d. When the inferior oblique shows the greater angle: Superior oblique, 32 degrees; inferior oblique, fifty-seven degrees.

e. Measurements of the specimen showing the greatest angle of the oblique planes with the anteroposterior vertical plane of the eyeball: Superior oblique, 67 degrees; inferior oblique, 60 degrees.

f. Measurements of the specimen showing the smallest angles of the oblique planes with the anteroposterior vertical plane of the eyeball: Superior oblique, 22 degrees; inferior oblique, 34 degrees.

Continuous line indicates plane of the superior oblique plane. Broken line indicates plane of the inferior oblique plane.

The long course of human development has been associated with an increase in range of ocular movement and with an increase in accuracy over that range. During this process the superior oblique has surrendered some of that strength which, before the extension of its origin to the orbital apex, it used to balance with its antagonist. The resulting physiologic imbalance of the opposing obliques, coupled with an appreciable imbalance in the planes of action of the obliques in their relation to the anteroposterior vertical plane of the globe, may produce an upshoot or abnormal action of the inferior oblique when the eye is adducted.

Also it is possible that certain cases of muscle imbalance, especially those seen in convergence and in divergence anomalies, can be due basically to a mechanical defect in the oblique muscle planes with the horizontal defects a secondary factor.

Such explanations are admittedly speculative, but there is some tangible basis for the assumption which is based upon the above data. Such explanation may help to clarify some of the uncertain phenomena related to the complex etiology of the vertical defects.

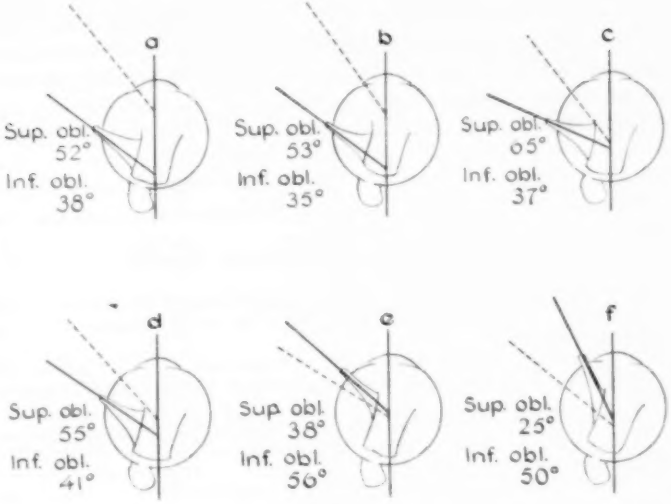

Fig. 7 (Fink). *Drawings of specimens which show variations of the muscle planes which do not fall within the average relationship.*

Continuous line indicates plane of the superior oblique plane. Broken line indicates plane of the inferior oblique plane.

Conclusion

Difference of opinion exists concerning causative factors in vertical defects. A study of available data indicates that our concept as to the cause of these conditions is based largely on supposition.

The purpose of this presentation is to assemble the available data and evaluate them on the basis of tangible evidence. A review of the literature supplemented by evidence as found by the writer in his clinical and laboratory experience is used as a basis of study.

The study indicates that vertical muscle defects may develop as the result of one or more factors. Although it is not always possible to determine the various causes present in all cases, the work suggests that certain vertical defects may be due wholly or in part to a disturbance in the peripheral mechanism. Evidence, therefore, suggests a tangible etiologic factor in certain cases of

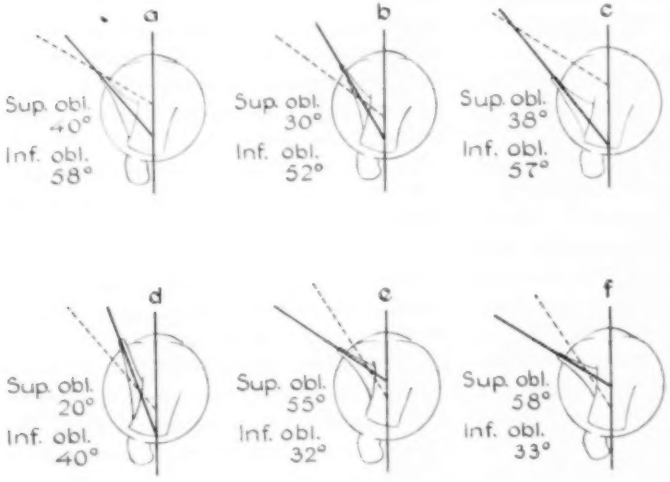

Fig. 8 (Fink). *Drawings of other specimens which show variations of the muscle planes which do not fall within the average relationship.*

Continuous line indicates plane of the superior oblique plane. Broken line indicates plane of the inferior oblique plane.

vertical muscle defects.

Until more accurate information is available and greater refinement in our diagnostic methods is achieved, our knowledge of the etiologic factors pertaining to vertical defects will continue to remain incomplete. Even with the most refined methods of investigation, certain factors may remain obscure.

Medical Arts Building.

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RIDLEY'S CATARACT OPERATION

ANDREW DE ROETTH, SR., M.D.
Spokane, Washington

The greatest change in cataract surgery in decades has been provided by the new method of Harold Ridley[1] (London). He replaces the removed lens with a plastic (acrylic, Transpex 1) lens, called lenticulus. The great advantages which this method offers:

1. Binocular vision can be restored because there is no, or in most cases only slight, anisometropia.

2. All difficulties connected with wearing a strong convex lens are eliminated. These difficulties are apparent nearness of objects due to the larger retinal image, smaller field of vision, prismatic effect if not centered, and weight of the strong convex lens. This operation changes the present-day cataract extraction from a mutilating to a reconstructive operation. Only one function of the lens, the accommodative, is not restored by this operation.

The disadvantage of this method is the danger inherent to any intraocular foreign body. An intraocular foreign body, according to our present knowledge, should be removed to avoid intraocular inflammation which may lead to sympathetic ophthalmia. Ridley has not seen this particular sequela though "slight serous iritis frequently follows the operation" and there is a tendency "for exudate to be deposited on the middle of the anterior lens surface."

Does the lenticulus stay in place, or does it gradually sink or tilt, or even lodge in the vitreous?

Does it cause late foreign-body reaction?

These are questions which can be answered only after several years of observation on a large number of cases.

Ridley stated that it is possible to insert an artificial lens into the human eye and to retain it accurately in position, without giving rise to inflammation or to glaucoma for at least two years. Vail,[2] in his discussion of

Ridley's paper at a recent Academy meeting, forcefully expressed his fear lest inexperienced surgeons use this dangerous procedure and pleaded that this operation should be considered only as an experiment for the time being.

Even if all the above complications do not occur and the initial iritis caused by the lenticulus has no serious sequelae, do Ridley's visual results stand up to our present-day standards? For the proof of the cataract operation is the visual result.

In a comparison of the results of Ridley's method and those of the orthodox operation, the results of the essayist's 406 successive operations of senile cataract are shown first:

Intracapsular extraction—343 cases (84.5 percent); the capsule tore but was fully removed in 32 cases (7.9 percent). Extracapsular extraction—31 cases (7.6 percent). Peripheral iridectomy—188 cases (46.4 percent); full iridectomy—218 cases (53.6 percent). In the last two years the percentage of peripheral iridectomy reached 70 percent.

Complications: loss of vitreous, 27 cases (6.7 percent). Early postoperative complications: hemorrhage in anterior chamber and/or vitreous 14 cases (3.4 percent). Iris prolapse, three cases (0.7 percent); iritis, seven cases (1.7 percent); choroidal detachment, eight cases (2.0 percent). Late complications: retinal detachment, five cases (1.2 percent), glaucoma, five cases (1.2 percent); epithelial downgrowth, three cases (0.7 percent); heavy vitreous blur, two cases (0.5 percent).

Visual results in 328 eyes (table 1). Cases, with extraneous conditions unrelated to cataract or to the operation, having poor visual prognosis, such as corneal scar, retinopathy, senile and myopic macular degeneration, optic atrophy, and preoperative glaucoma, are excluded.

TABLE 1

VISUAL RESULTS IN 328 EYES

Vision	20/15–20/30	20/30–20/70	20/70–20/200	Less than 20/200
Number of Eyes 328	286	25	4	13
Percentage	87.2	7.6	1.2	4.0

TABLE 2

RESULTS IN INTRACAPSULAR AND EXTRACAPSULAR METHODS

Vision	20/15–20/30	20/30–20/70	20/70–20/200	Less than 20/200
Intracapsular 301 eyes	270	18	1	12
Percentage	89.7	6	0.3	4
Extracapsular 27 eyes	16	7	3	1
Percentage	59.3	25.9	11.1	3.7

Table 2 shows the results of intracapsular and extracapsular methods.

Statistics of other authors follow. All show the percentage of cases with 20/30 vision or better and, in all, the eyes with extraneous causes of poor vision are excluded:

Hilding,[3] 88 percent of 159 cases.

Hughes and Owens,[4] D Series, combined intracapsular, corneoscleral suture, 85.7 percent of 425 cases; E Series, round pupil intracapsular, corneoscleral suture, 91.7 percent of 380 cases; however, their statistics do not include extracapsular operations with corneoscleral suture and the unsuccessful intracapsular attempts with rupture of the capsule.

Kirby,[5] 91.1 percent of 90 cases.

Knapp,[6] 90 percent of 500 successive cases of intracapsular extraction; in cases of extracapsular extraction it was 52 to 62 percent.

O'Brien,[7] 91.8 percent of 233 cases.

Roper,[8] 84.6 percent of 117 cases.

Ridley reported 27 cases in March, 1952. Four of these cases (24 through 27) were too recent to have had their vision checked and one (Case 2) had preoperative iridocyclitis. Though Case 12 had a traumatic cataract with intraocular foreign body, it has been included in the 12 cases with good vision. Out of the remaining 22 cases only 12, that is 54.5 percent, had 20/30 or better

vision. This is too small a series to be statistically significant.

In his paper given at the meeting of the American Academy of Ophthalmology and Otolaryngology (Chicago, October, 1952), reporting on the first 60 cases, Ridley stated that 50 percent had 20/30 or better vision.

This is not up to our present-day standards, especially in view of the fact that this operation can be done only in the most favorable cases. It is highly doubtful that the optical advantages of this operation make up for the poor visual results and for the dangers inherent to an intraocular foreign body.

When comparing the visual results of different methods, not only the percentage of the good but also that of the poor results, vision less than 20/200, should be considered. With the orthodox method this is between two and four percent. In Ridley's report of 27 cases there were two cases (2 and 15) in this bracket. But Case 2 has to be excluded because of preoperative iridocyclitis and increased tension. The remaining one case would make the percentage about four percent. But the series is too small and too short a time has elapsed to show other possible late complications, such as glaucoma, late foreign-body reaction, retinal detachment, and dislocation of the lenticulus.

A further point is that a high degree of anisometropia with the resulting aniseikonia was not eliminated in all his cases. There was a difference of refraction between the operated and the fellow eye of 4.0D. or more in five cases (1, 2, 17, 18, 20).

It is not clear whether Ridley recommends this operation as a routine one. In one sentence he writes that "ordinary cataract patients need no longer suffer the disabilities inseparable from the use of very strong glasses." In the next he states: "It is too soon, however, to claim that this operation renders earlier techniques obsolescent, though this would not appear to be impossible."

Summary

Ridley's new cataract operation offers several important optical advantages. However, the frequent postoperative iritis and the danger of dislocation of the lenticulus and more especially the poor visual results weigh too heavily against this method, therefore it must be rejected as a routine cataract operation. As Vail suggested, it should be considered as an experiment.

Old National Bank Building (8).

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SPHEROPHAKIA WITH BRACHYDACTYLY

Comparison with Marfan's syndrome

Lloyd A. Probert, M.D.*
Moose Jaw, Saskatchewan

Introduction

The literature on spherophakia goes back to 1901, when Cordiale reported the first case. Shapira, in 1934, reported two cases seen in the Elschnig clinic, and surveyed the literature to that date (16 cases). All the cases were bilateral except that of Cordiale. No more than 24 cases of spherophakia have been reported, and the great majority of these are from continental Europe.

Spherophakia associated with brachydactyly has been described only twice. Marchesani, in 1939, drew attention to spherophakia and brachydactyly as a syndrome. He described cases of spherophakia and brachydactyly in which brachydactyly was present in the families of one of the parents. Meyer and Holstein, 1941, reported a family in which four out of seven siblings showed spherophakia with brachydactyly. Three of these had a complicating glaucoma. The mother and father were first cousins, both of short stature but with normal eyes. Due to the consanguinity in this family and the frequent report of consanguinity in other families with spherophakia, they regarded this as a recessive inherited abnormality.

Case reports

Figure 1 shows the pedigree. You will notice that brachydactyly is inherited through three generations, while spherophakia is seen in only one generation.

Mrs. H. S., aged 42 years, showed spherophakia, ectopia lentis, and brachyphalangy. The vision was fairly good until she was 20 years of age, when an eye examination revealed that she was short sighted. On examination the corrected vision = 20/70, O.U. The lenses were dislocated upward, iridodonesis was present, and the fundi were normal. Both little fingers were shorter than normal.

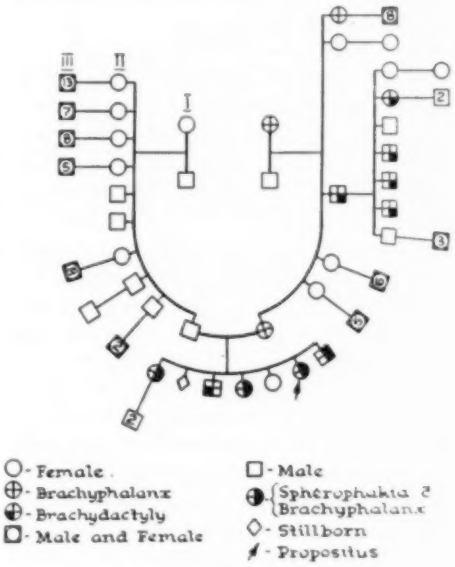

Fig. 1 (Probert). Spherophakia with brachydactyly.

Mr. S. M., aged 38 years, showed brachydactyly. The eyes were normal. The patient was of short stature, the extremities being very short. The fingers were practically all the same length.

Mrs. M. B., aged 37 years, showed spherophakia, ectopia lentis, and brachyphalangy. The vision was good until she was 10 years of age. On examination the corrected vision = 20/100, O.U. The corneal diameter was: O.D., 13 mm., O.S., 12 mm. The lenses were dislocated upward, iridodonesis was present, the vitreous was fluid, and, surrounding each disc, was an area of choroidal atrophy. Both little fingers were shorter than normal.

* Fellow in Ophthalmology at the University of Toronto Medical School supported by a grant from the Canadian National Institute for the Blind.

TABLE 1

EYE FINDINGS IN FAMILY STUDIED

	Age (yr.)	Vision Began to Fail	Vision Without Glasses	Vision With Glasses	Correction	Lens	Cornea Measurement (mm.)	Cephalic Index	Skeletal Abnormality
Mrs. C. M. (mother)	61	Normal	O.D., 20/50 O.S., 20/40	20/30 20/30	+0.50 ○ +0.50 × 120° +0.50 ○ +0.50 × 60°	Normal	O.D., 11 O.S., 11	82.4	Brachyphalangy Syndactyly
Mr. E. M. (father)	65	Normal	O.D., 20/30 O.S., 20/40	— —	— —	Normal	O.D., 12 O.S., 12	88.8	Normal
Mrs. H. M.	42	20 yr.	O.D., 20/300 O.S., 20/300	20/50 20/70	−12.0 ○ −2.00 × 180° −11.50 ○ −2.50 × 180°	Spherophakia Dislocated	O.D., 11 O.S., 11	83.3	Brachyphalangy
S. M.	38	Normal	O.D., 20/30 O.S., 20/15	— —	— —	Normal	O.D., 11 O.S., 11	79.0	Brachydactyly Syndactyly
Mrs. M. M.	37	10 yr.	O.D., 6/200 O.S., 6/200	20/100 20/100	−14.0 ○ −2.00 × 180° −14.0 ○ −2.00 × 180°	Spherophakia Dislocated	O.D., 13 O.S., 12	83.0	Brachyphalangy
Miss P. M.	26	11 yr.	O.D., H.M. O.S., H.M.	C.F., 18″ C.F., 18″	−12.0 ○ −4.00 × 180° −13.0 ○ −2.00 × 180°	Spherophakia Dislocated, glaucoma	O.D., 11 O.S., 11	82.4	Brachyphalangy
G. M.	24	6 yr.	O.D., 10/200 O.S., 10/200	20/70 20/70	−15.0 ○ −2.00 × 180° −14.0 ○ −2.00 × 180°	Spherophakia	O.D., 13 O.S., 13	73.6	Brachyphalangy

Miss P. M., aged 26 years, showed spherophakia, ectopia lentis, glaucoma, and brachyphalangy.

The vision began to fail when she was 11 years of age. On examination corrected vision = counts fingers at 18 inches, O.U. The corneal diameter was 11 mm., O.U. The tension was 60 mm. Hg (Schiøtz), O.U. The lenses were dislocated upward and outward; iridodonesis was present. The patient had a bilateral trephination in 1948 for glaucoma. The true nature of condition was not recognized at that time. In 1950, the left lens was removed, but with no relief of the increased tension. Both little fingers and the left thumb were shorter than normal.

G. M., aged 24 years, showed spherophakia and brachyphalangy. The vision began to fail when she was six years of age. On examination corrected vision = 20/70, O.U. The corneal diameter was 13 mm., O.U. With a dilated pupil the whole circumference of the lens could be seen inside the pupillary border. The zonules were intact. The optic discs were pale. Both little fingers were short.

DISCUSSION

1. The eyes are usually of normal size, although some show abnormally large corneas. If the normal range of diameter of the cornea is taken as from 11 to 12.5 mm., then, two of my four patients with spherophakia showed large corneas.

2. No abnormality of vision is noticed until five to 10 years of age. One of our patients had good vision until 20 years of age.

3. The first change noticed is a small, spherical lens, obvious zonules which are usually intact at this stage, and no dislocation. The small size of the lens will not be noted unless the pupil is well dilated. There is high myopia but a normal fundus.

4. During the teens and twenties the lenses invariably become dislocated. Iridodonesis is present, the myopia has increased, but the fundus remains normal. The refraction through the aphakic portion of the pupil is that of an aphakic eye. Three out of four persons affected with spherophakia in this pedigree had dislocated lenses.

5. Glaucoma is the feared, and almost inevitable, complication. It occurs: (a) Without a dislocated lens, and is due to the soft anterior lens substance blocking the pupillary zone and hindering the flow of aqueous from the posterior to the anterior chamber. (b) It also occurs as a complication of dislocation (1) by irritation of the ciliary body, (2) by blocking the angle, or (3) by complete luxation into the anterior chamber.

With the occurrence of glaucoma, there is ciliary congestion, further loss of vision, and cupped discs. Glaucoma developing in

spherophakia may be spoken of as inverse glaucoma, whereby miotics tend to bring on an attack of acute glaucoma, while mydriatics tend to relieve the pressure.

In actual practice it is usually found that mydriatics will not relieve the increased tension, but if a miotic has been given first and the tension increases rapidly, then a mydriatic counteracts this effect and returns the tension toward its original level. In those cases in which tension studies have been made it is found that the pressure falls toward evening, and is lowest during the night, only to rise again in the morning and during the waking hours.

Comparison of the lenses to the normal

The lenses are one-quarter to one-fifth less in weight than the average; the equatorial diameters are smaller but the sagittal diameters are larger than normal. Spherical lenses which have been weighed are approximately 0.14 gm. in weight. This is the average weight of a lens in a 10-year-old child.

From this and the observations that good vision is retained until 10 years of age, it may be concluded that spherophakia is due to a lack of development of the lens and zonules after the age of 10 years. In the literature Fleischer says spherophakia is due to an abnormal development of the lens, and Saeger suggests a lack of development of the zonule.

Genetics

The present pedigree (fig. 1) offers an interesting genetic problem. The mode of inheritance is by no means clear, and could be explained by one of the three following possibilities:

1. The character for brachydactyly shows a dominant transmission through three generations. The character for spherophakia occurred in the siblings of only one generation, and may be considered recessive. Four of the five siblings received the chromosome from each parent carrying spherophakia. Due to the modifying effect of this gene, the four affected with spherophakia showed brachyphalangy. In the one sibling receiving no gene for spherophakia, the brachydactyly was allowed its fullest expression, and he shows normal eyes with a complete brachydactyly.

2. The spherophakia may have been due to a dominant mutation arising in either the mother's or father's gametes, and transmitted to the offspring. If it arose in the mother on the same chromosome as the gene for brachydactyly, then there is a genetic linkage, and the boy showing no eye defect could have been a crossover between the two loci.

3. There may be one pleiotropic gene for this syndrome transmitted by the mother, but, due to the lack of penetrance or due to the genetic modifiers in her parents, the eye defect may not have shown. In the parents of the affected sibship, however, there may have been no modifiers transmitted by the father and we see the complete syndrome.

It does appear as if the character for

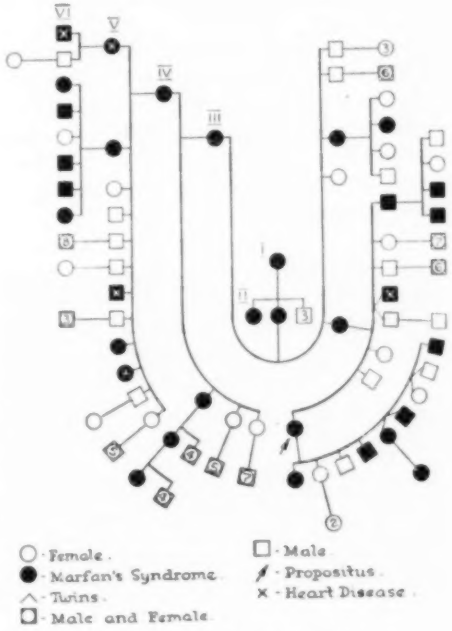

Fig. 2 (Probert). Marfan's syndrome.

TABLE 2

FINDINGS IN MARFAN'S SYNDROME AND IN SPHEROPHAKIA WITH BRACHYDACTYLY

Marfan's Syndrome	Spherophakia with Brachydactyly
1. Dolicocephalic or mesocephalic skull	1. Brachycephalic or mesocephalic skull
2. Long, aesthenic build, tapering fingers, little subcutaneous fat, poorly developed musculature, kyphosis, and congenital abnormalities of heart	2. Short, pyknic build, short fingers and toes, good subcutaneous fat, well developed musculature
3. Lens of normal size	3. Lens smaller than normal
4. Ectopia lentis may be congenital	4. Ectopia lentis occurring later in life
5. High myopia due to dislocated lens and lack of normal tension when suspensory ligaments are torn	5. Very high myopia due to spherical shape of lens, becoming worse when dislocated
6. Vision usually defective from infancy	6. Vision good, until 5 to 10 yr. of age, then becomes progressively worse
7. If the lens is not dislocated, it appears normal and vision is normal	7. If the lens is not dislocated, the whole circumference of the lens can be seen inside the pupillary border
8. Inherited as a dominant character	8. Inheritance is not known for sure. It may be inherited as a recessive character

spherophakia has some modifying effect upon the skeletal abnormality, because the brachydactyly was mild in those affected with the eye trouble and severe in the one boy with normal eyes. This hypothesis of a pleitropic gene would seem the most plausible explanation if one compares the mode of inheritance to Marfan's syndrome.

COMPARISON OF SPHEROPHAKIA AND BRACHYDACTYLY WITH MARFAN'S SYNDROME

Marchesani believed these two diseases were fundamentally dysplasias of mesodermal structure, and suggested the terms "dystrophia mesodermalis hyperplastica" for spherophakia with brachydactyly, and "dystrophia mesodermalis hypoplastica" for Marfan's syndrome.

Figure 2 shows a pedigree of Marfan's syndrome in which the eye condition of 140 individuals is known; 32 of these have ectopia lentis with arachnodactyly. The affected individuals varied in the severity of the disease from a "forme-fruste" to a fully developed picture of Marfan's syndrome. The reader is referred to a paper by Lutman and Neel for a thorough study of this syndrome.

SUMMARY

A family showing spherophakia with brachydactyly is described. Brachydactyly is dominant through three generations and spherophakia with brachydactyly is seen in only one generation. Therefore one cannot be sure of the mode of inheritance, but three possibilities are discussed.

The fact that this family shows brachydactyly in two generations and brachydactyly with spherophakia occurring in four out of five children in the third generation, and the reports in the literature of two other similar situations, leads one to believe that this is a definite syndrome. This belief is fortified when Marfan's syndrome, another skeletal-eye abnormality, is considered.

303 Scott Building.

I would like to thank Dr. Lloyd Butler for his help with the genetics, and Dr. Clement McCulloch for his help with the clinical aspects and preparation of this paper.

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DELAYED MUSTARD-GAS KERATOPATHY*

FREDERICK C. BLODI, M.D.
Iowa City, Iowa

It has been well established that a keratopathy may occur many years after a severe exposure to mustard gas (dichlorodiethyl sulfide). Usually 10 to 15 years elapse before this delayed keratopathy appears, causing photophobia and pain.

More than 100 cases have been reported in the European literature, but so far only four instances have been described in this country.[1,2] This is a surprisingly small number when compared with the actual number of soldiers (more than 50,000) who experienced acute mustard-gas poisoning. This is the first patient reported from a veterans hospital, where one would expect that these cases should come for treatment and diagnosis.

CASE REPORT

The 57-year-old Iowa farmer A. D. M. (No. 1607) was gassed in France in 1918. He was hospitalized soon after the injury and stayed in the hospital for six weeks. His eyes were red and swollen, but after two months they cleared up. During this period he developed a cough which became chronic and has persisted since then. Later on he developed asthmatic attacks and, in 1947, he had a spontaneous pneumothorax on the left side. His present hospitalization is because of pulmonary emphysema and bronchial asthma.

In 1949, for the first time, the patient had pain in his right eye, and his vision seemed to fail slowly. He was treated for corneal ulcer and was relieved of his pain until the summer of 1952.

Examination of his eyes revealed the following:

The right cornea shows four areas of superficial calcium deposition (fig. 1). These lie in the interpalpebral fissure or below it. In addition similar opacities are found at the limbus near the 3- and 9-o'clock positions. The conjunctiva shows the typical "marbling" effect; that is, a disappearance of the smaller vessels with superficial calcium incrustation. The conjunctival vessels around that area are dilated and tortuous. On the temporal side they also show some aneurysmatic dilations.

There is a dense, saucer-shaped opacity in the posterior cortex of the lens.The fundus appears normal and vision is 20/200.

The left cornea shows three similar superficial calcareous lesions in the center (fig. 2). In addition there are white opacities at the limbus in the interpalpebral fissure. The conjunctiva shows a "marbling" effect in that area, with dilation and tortuosity of the conjunctival vessels around it. A wide aqueous vein can be seen behind the pathologically altered conjunctiva on the temporal side. It merges with a conjunctival vein showing stratification.

There are only a few opacities in the pos-

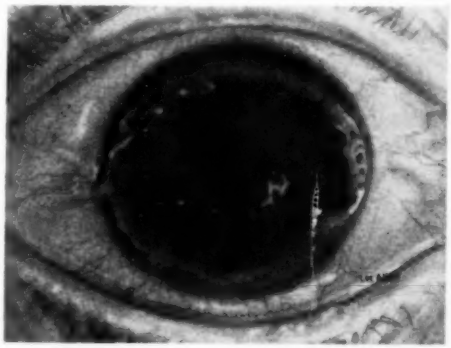

Fig. 1 (Blodi). Mustard-gas keratopathy, right eye.

* From the Veterans Administration Hospital and the Department of Ophthalmology, State University of Iowa. Published with the permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the author.

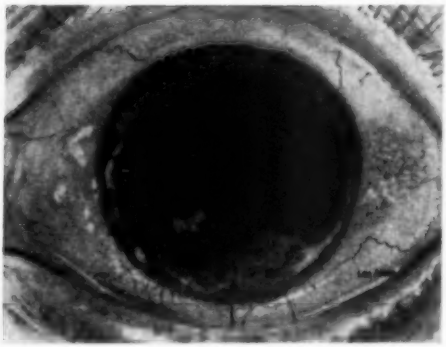

Fig. 2 (Blodi). Mustard-gas keratopathy, left eye.

terior cortex of the lens. The fundus appears normal and vision is 20/40 with correction.

The lesions described and illustrated are characteristic for the delayed mustard-gas keratopathy as described by Atkinson.[2] Superficial, partly calcified lesions are found in the cornea with the triangular, pale patches of conjunctiva close to the limbus in the interpalpebral fissure. These conjunctival patches are void of vessels and contain some calcium (marbling). The conjunctival vessels around it are tortuous, distended, and show a few aneurysmatic dilations.

Therapy has been a conservative one. The patient is bothered by his corneal lesions only when he experiences an extensive epithelial breakdown, and this apparently occurs very rarely. The original reports on the beneficial influence of contact lenses could not be substantiated.[3] Conjunctival grafting has been tried with success in one case.[4] A more extensive surgical procedure, for instance a keratoplasty, cannot be contemplated because of the severe cough and asthma of the patient. Because of a recurrent attack of corneal erosion one eye was treated with EDTA, as advised by Grant.[5] Most of the calcium disappeared and the patient is still without discomfort eight months after operation.

Summary

A fifth American case of delayed mustard-gas keratopathy was observed in a veterans hospital. The first symptoms occurred 21 years after the initial injury.

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Ophthalmic Miniature

There are some very fine men upon this island whose skins are whiter than any European's, but of a dead color, like that of the nose of a white horse; their eyes, eyebrows, hair and beards are also white.

Their bodies are covered, more or less, with a kind of white down. Their skins are spotted, some parts being much whiter than others. They are short-sighted, with their eyes oft-times full of rheum, and always looking unwholesome, and have neither the spirit nor the activity of the other natives.

The Voyages of Capt. James Cook Around the World,
Tahiti: 1769.

VISUAL FACTORS IN READING: WITH IMPLICATIONS FOR TEACHING

HELEN L. HULSMAN
Brockton, Massachusetts

INTRODUCTION TO THE PROBLEM

If a child cannot read there are always reasons; however, these causes may not be easy to determine. Tests may have shown that he is mentally capable of the task, but the trouble may be an educational one, the result of either inadequate teaching or of his absence during lessons of critical importance. The child may be emotionally upset so that he lacks, temporarily, the desire or the ability to concentrate on skills.

If neither of these factors seems to influence his work, the reason for his failure to learn may be a physical one. Perhaps, however, the child's health seems good and his physician has found nothing wrong with him. Moreover, his eye test at school has shown that he has good vision at a distance of 20 feet.

Why can't he read? In spite of the results of the school vision test, his eyes may still be troubling him and his reading.

In this report, I plan to discuss why the school test does not always locate the visual difficulty, several kinds of eye defects and visual defects, and controversies about their relation to reading. Studies showing the effect of the visual errors in reading, the results of correcting the defects of vision, and the implications for teaching suggested by the studies will also be considered.

SCREENING TESTS*

The school screening test for visual acuity is not always an adequate one. The laws of some states specify the use of the Snellen test, but there are several more efficient measures, at least two of which (the Massachusetts Vision Test and the Eames Eye Test) contain a Snellen component and meet the legal requirements.

Some of the improved tests are comparatively expensive or they must be administered by trained technicians. These facts result in their not being used generally.

The Keystone Visual Survey with the telebinocular may be administered by the teacher. The Orthorater, the Sight Screener, and the Massachusetts Vision Test, however, should be used by trained technicians.

The Eames Eye Test may be bought for a few dollars and may be administered by the classroom teacher. It checks many visual factors which will be discussed later, and this test might well be used generally for help in deciding which children should see refractionists. It has not yet been made available for all schools.

The Snellen chart, however, although it locates 60 percent of the pupils needing visual help, tests only for vision at a distance of 20 feet. Both the teacher and the child might think that his vision is normal because the chart, blackboard writing, large objects, and distant views may be seen clearly.

What is more, by straining his eyes he may see the print in books without realizing that he has an eye defect which hurts his ability to see clearly at the reading distance. For this reason, many pupils with eye defects are not located and referred to specialists.

School vision tests, then, are not always adequate in locating pupils with eye defects.

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* Massachusetts Vision Test
Welch Allen Co., Auburn, New York.
Eames Eye Test
World Book Company, Yonkers-on-Hudson, New York.
Keystone Visual Survey
Keystone View Company, Meadville, Pennsylvania
The Orthorater
Bausch and Lomb Optical Company, Rochester, New York
Sight Screener
American Optical Company, Southbridge, Massachusetts

Kinds of eye defects

Some of the more common eye difficulties will be discussed briefly. Chief among these are the refractive errors in which the eyes are out of focus.

In one of these errors of refraction, farsightedness or hypermetropia, a "widely accepted theory" is that the horizontal diameter of the eyeball is shorter than the vertical diameter. As a result the rays focus farther back than the retina with the result that the image is not clear.

Another refractive error, myopia or nearsightedness, is the reverse. The eyeball is thought to be longer horizontally than vertically. Therefore, the image is formed before it reaches the retina so that the retinal picture is not clear.

Another theory as to the cause of these two difficulties is reported by Kottmeyer.

Although the former reasons are the "widely accepted" ones, other eye doctors believe that farsightedness and nearsightedness are caused by an improper ratio in the use of the muscles of accommodation and of convergence. If a young child enjoys reading, he is likely to practice near accommodation and to develop myopia, it is stated. Otherwise he may stress far accommodation and become farsighted.

Whatever the cause may be, these two refractive errors are among the most common ones reported in the studies conducted by me.

A third error of refraction is astigmatism, caused by a defect in the curve of the cornea or of the lens of the eye so that focusing is impaired. Rays in the meridian of the defect are refracted away from the focal point.

A person's vision may be affected, too, by anisometropia or wrong binocular vision in which images in the two eyes focus at different points. For example, one eye may be farsighted and one nearsighted, or one eye may be normal and one eye astigmatic.

Another difference between the two eyes, aniseikonia, causes images of different sizes and shapes to be formed on the retinas. As a result, even with good fusion, one image would be superimposed on the other leaving an imperfect picture.

Stereopsis is another quality with which studies are concerned. This power, depth perception, depends on good binocular vision because each eye sees an object from a slightly different angle, a fact which makes the depth of the object more apparent.

Considered also in visual studies are the phorias, which are cases of muscular imbalance or inco-ordination. The prefixes of the related words describe the type of imbalance. In exophoria, the eyes have a tendency to turn outward. Esophoria is the reverse, while in hypersophoria the eyes turn upward. These visual factors are chief among those that have been examined in recent studies.

Controversies about the relation of eye defects to reading

Because reading is so closely related to the use of the eyes, there would seem to be no doubt as to the harmful effect on reading of any visual or eye defect. But there seem to be controversies among the research workers.

Some writers state that "visual disturbances are largely responsible for reading difficulties." Others feel that there is "no relation between the two" or that "visual disturbances are one of the many factors which may be operative in any case of reading disability." A few seem to feel not that poor eyes may cause poor reading but that "visual disturbances and poor reading may have a common cause." Still others state that "certain types of visual anomalies may be produced by a successful reading adaptation."

Studies as to the kinds of handicapping visual factors at school likewise show conflicting answers, depending on the population studied, the test methods and standards used, and the background and technique of the research worker. The chief eye defects "most readily screened out" have been hyperopia and muscle imbalances. Their importance and "the presence and importance of less obvious faults of fusion, suppression, alternation, and so forth, appear to be problems for solu-

tion by the professional man in each case." The reason for much of the lack of agreement seems clear.

Eames has found that many studies of the causes of reading failures have not been completely successful because of "variation in the background of the investigators. Physicians, psychologists, optometrists, teachers, and others" have made the tests using all kinds of techniques, "ranging from the conventional to the bizarre." Moreover, "the dividing line between reading failure and reading disability continues to be vague."

It seems to me that, if studies are made to find the effect that the various eye defects have on reading, more valid conclusions may be reached if the work is done with the co-operation of both oculists and educators.

Teachers know little about eye testing, and eye specialists are not trained in the testing of reading. Both together might define and equalize standards so that the findings of one study might more profitably be compared with conclusions of other research in the same field. However, the independent studies are of interest and of value to one who seeks to know more about the child and his vision or reading.

Studies of eye conditions

Several of the recent studies have located visual difficulties among poor readers. Eames made a study of eye conditions among 1,000 poor readers, 500 ophthalmic cases, and 150 unselected cases. The first group had a median age of nine years, eight months, the second group of 11 years, six months, and the last group of 10 years, eight months. The median intelligence quotients were 102, 103, and 109, respectively. The same doctor tested each one and the same tests were given.

Noteworthy among the findings was this fact: "The poor-reading and ophthalmic groups presented medians of six prism diopters of exophoria at the reading distance as against three prism diopters among the unselected cases." It was stated that this conclusion supports earlier findings by Eames.

In addition to the eye defect mentioned, "hypermetropia, retarded speed of word recognition, and intelligence quotients below 90" were found more often among the poor readers than among the others, although the medians were not much greater.

Eames states that the study supports clinical observations "that reading failures are often troubled to a greater extent than others by such handicaps as low degrees of hypermetropia and other eye defects."

Supporting Eames's findings was a study by Park. He reported the frequencies of eye difficulties among 133 cases of dyslexia. Both Park and Eames found that exophoria at the reading distance was important among children having reading difficulty. Park found that four prism diopters of correction made an important difference as compared with six prism diopters in Eames's study. Park also found a high lack of stereopsis among the poor readers, and stated that "ametropia must be considered a factor in some cases of dyslexia." He believes that this ametropia should be corrected by glasses but is not in favor of "the empirical prescribing of glasses to help a reading disability."

The general use of glasses will be discussed later.

In summarizing the results of previous studies and in stating what she had found to be true in the reading clinic in Chicago, Robinson supports Eames and Park as to the incidence of hypermetropia and binocular inco-ordination among the poor readers. She also lists as important hyperopic astigmatism, visual fields, and aniseikonia if younger children are being studied.

Eames and Fernald differ on the importance in reading of binocular co-ordination.

Eames states that "the superimposition of images of words and letters that often occurs in exophoria creates mental impressions of a composite word or letter form which may be quite unfamiliar, or may blend into a familiar looking symbol."

If an "F" were superimposed on an "L,"

an "E" would result. This condition would cause words to look strange.

On the other hand, Fernald states that reading may increase the efficiency of eye coordination. She found that "as reading skill developed, the eye adjustments became normal and all evidence of fatigue disappeared."

Stressed most in all these reports were hypermetropia and exophoria at the reading distance. Whether these defects were the chief causes of the poor reading has not been proved. But it is my opinion that even a good reader would be hindered by the strain of trying to accommodate enough to compensate for farsightedness.

Moreover, it would seem that trying to counteract a tendency for the eyes to turn outward would make focusing, especially on near objects like the printed page, an extra strain. Such tension would make reading unpleasant if not impossible, and a dislike for close work could be a definite hindrance in learning to read.

Strange as it may seem, some studies question the importance of eye defects in their relation to reading. Traxler states that the results of many studies suggest "that the relationship between visual defects and reading disability is not as high as one would naturally expect it to be." He states that reading will be greatly affected by severe impairment of vision but that most pupils "seem to be able to compensate for minor eye defects."

Visual difficulties are nearly as common among the good readers as among the poor ones, Traxler finds. However, "special visual defects such as aniseikonia, or difference between the size and shape of the retinal images in the two eyes do seem to influence reading achievement significantly."

This defect, aniseikonia, was one that Robinson, too, found to have a high incidence among reading failures.

Less important among the reading failures, according to recent studies, is myopia or nearsightedness. May and Perera report that there is some hereditary tendency toward this defect, and that endocrine disturbances or deficiencies of diet might also be predisposing factors. Precipitating causes may be "excessive study or close work, especially when associated with insufficient outdoor exercise or relaxation, indistinct print, poor illumination, . . . faulty posture, faulty construction of desks, and poor health."

Luckiesh and Moss agree, generally. They believe that myopia is not unpreventable but that it might be caused by "slavery to more and more prolonged tasks of near-vision."

Although myopia might affect blackboard work, Robinson finds that it is probably not a cause of poor reading and that it may even be an asset to good reading. Although it is undesirable in general vision because of the fact that it may grow progressively more pronounced, according to the literature quoted myopia seems not to be a factor in poor reading.

No studies on astigmatism made during the last decade have been found by me but several were completed somewhat earlier. Robinson summarizes those made by Betts, Fendrick, Eames, and others. Astigmatism was not associated closely with poor reading, according to the studies made. In certain cases, it was associated with better-than-average reading. However, Betts and Eames believed that "it might be a serious handicap, in individual cases, especially when present in higher degrees."

Amblyopia or partial blindness seems more important as a factor in poor reading. Eames made a study in which he examined for the incidence of amblyopia 100 children failing in reading and, as a control group, 100 children not failing in reading but referred for ocular trouble. The ages of both groups ranged from six to 19 years.

If a child had less than 20/20 vision in either or both eyes without apparent lesions, and if the vision was unimproved by the use of lenses, the child was judged to have amblyopia. The findings showed a much greater incidence of this defect among those with reading difficulty, and the left eye only was

affected more often in the poor-reading group.

Eames believes that amblyopia may be "either a neurologic defect, concomitant with partial word blindness, or a primary factor impairing reading ability through visual inefficiency."

School clinicians might well investigate the birth histories of pupils failing in reading. The results of two studies recently made by Eames indicate that prematurity of birth may be related to reading failure or to low vision.

In the first study a random sampling of 100 cases of reading failure was studied. They were investigated for birth history and known physical handicaps. The group was divided into two sections, paralleled by sex, median mental age, refractive errors, and right eyedness with right handedness.

The findings showed that 15 percent of the children had been premature at birth, this number being a much larger proportion than would be expected in unselected cases. This premature group showed 17 percent more defective vision and a slower median speed of recognition of both pictures and words. Half of the premature group fell below the first quartile in the speed of recognizing pictures, although this skill was considered easier than that of the recognition of words.

From this study and the following one, it seems to me that prematurity at birth may be an important factor in a child's reading efficiency.

In a related study, Eames compared, for educational implications for grades one through 12, 155 children of ages five through seven years who had been premature at birth, 439 children of full term birth, and 25 children of hypermature birth. The findings showed that the premature group had a "higher frequency of low vision at all of the ages studied, . . . and poorer median visual acuity through the ninth year."

I believe that these two studies indicate that children of premature birth may have a continuing lack of maturity in vision and in reading ability during several school years. If teachers knew the background of the children, they would be able to adjust material better to their ability levels.

To what extent does fatigue influence reading or the rate of blinking? Dodge made a study of one subject for the effect of fatigue on left-to-right eye motions. The pupil was required to move his eyes from left to right as in reading, fixating on two knitting needles 30 degrees on either side of a point. A photographic record of his eye motions showed a series of dashes broken by the alternating of electric current. At the end of the period, the subject showed less speed of eye motion, less accuracy of fixation, and a more irregular line of movement. It appeared to the tester that fatigue can make the eyes less efficient.

A related study was made by Robinson. A group of 115 pupils in grades four through six and in grade 12 was given visual tests and the Gray Oral Reading Check Test, both before and after 30 minutes of continuous reading.

Robinson found that there were no significant changes in oral reading rate, number of errors, or in visual performance. Fatigue evidently did not affect the reading efficiency of the pupils tested after a half hour of steady reading.

Carmichael and Dearborn found similar results with high-school and college students after a much longer period of continuous reading. They were tested after six hours of steady reading, and they manifested no significant signs of visual fatigue or lessened efficiency in reading.

Carmichael and Dearborn believed that motivation "forestalls fatigue, but Bitterman took exception to the idea of no decrease in efficiency. He believed that motivation made the effort more steady and thereby forestalled decrement."

Bitterman made a study to see whether or not fatigue, increased by distractions, would influence the rate of blinking. Ten college students doing clerical work were subjected

to the continuous playing of the recorded voice of a man who was reciting numbers from one to 10 digits in length. They worked for four 15-minute sessions, the records being played during alternate periods. Electromyographic tracings were made of their eyelid activity.

The results showed no increase in the frequency of blinking during times of distraction, although, Bitterman believed, greater effort had to be expended in order that the work might remain steady.

These studies seem to me to indicate that, although long periods of steady work or distracting sounds may make one more fatigued, a person doing mental and eye work may compensate for the added strain by extra effort so that the apparent efficiency is not decreased. I believe, however, that a teacher should realize that pupils do not always feel the high motivation required. In such a case, the work might be impaired.

Moreover, the effect on the total person of long periods and of distraction would be fatiguing and relatively harmful to his health and to his ultimate efficiency. For a teacher, the planning of shorter periods of concentrated work and freedom from unnecessary distraction for his pupils would seem to be desirable.

Visual factors that might be harmful to education have been considered. These reports may be contrasted with the findings of a study by Wirt and others as to the eye traits of pupils who were highest on the Standard Achievement Test. These eye traits were detected by the Orthorater, a screening device used in industry. Tests were given to 248 pupils in grades three through six. The eye traits exhibited by those pupils highest in achievement were "near acuity, color vision, and near vertical phoria posture."

Although color vision has not been mentioned previously, the other two conclusions seem to me to agree with the previous general indications that hypermetropia and phoria, especially exophoria at the reading distance, might be related to poorer academic work and that myopia might cause less disturbance in reading.

Even with good natural vision or well-corrected visual defects, however, a child may still be a poor reader.

Robinson finds that visual defects are the cause of reading difficulty in some cases but that they are only coincidental in others. She maintains that visual perception needs much more than a clear image, a fact that many investigators without a knowledge of the reading field have overlooked.

It seems to me, however, that, in the light of the foregoing studies, the visual acuity of a child who is failing in reading should be determined by an oculist so that any possible correction might be made in case of an eye deficiency. Even if the educational work does not improve, the child will be less subjected to discomfort and visual strain in case of eye trouble.

Effect of correction of certain eye defects

The discussion just presented has been concerned chiefly with eye defects and their possible relations to reading. Consideration will now be given to the results of the correction of such defects.

Gellerman believed, from a study of 60 cases of children with educational difficulty, that visual and auditory defects were among the most frequent precipitating causes, but that there were complicating factors such as poor teaching techniques or low motivation. He regretted that when glasses had been provided the cases had been forgotten, since more than eye defects are often involved.

Eames discusses the desirability of glasses and of eye exercises. He believes that many people have mistaken ideas about the efficacy of these corrections. For example, glasses will help the eyes merely to focus correctly, but they cannot affect their sensitivity. If a disease has affected the tissue, glasses will not help.

Another wrong idea that people have, he believes, is that glasses are always needed for

eye trouble. But the aid needed may be "rest, medical treatment, or orthoptic exercises."

A third error in thinking, Eames believes, is that eye exercises are always helpful. There is a legitimate kind, prescribed by an oculist, that may help the eyes "to see more discriminatingly" or to "work together." Some exercises may aid in teaching the mind to combine two separate pictures. But such illegitimate exercises as the "throw-away-your-glasses" kind, may furnish only temporary improvement with bad later consequences in "muscular spasm, photochemical depletion," and the like.

If the eye doctor does not recommend glasses after a child fails in the school vision test, it may be that the eyes are insensitive or have blind areas, in which case glasses would not be helpful.

Fortunately, however, there might be a much simpler reason. The eye test at school might have been administered after a study period with the result that the eyes were not relaxed and were "artificially nearsighted for a few minutes or perhaps half an hour or longer." In such a case, there would be no real trouble with the eyes, and glasses would not be desirable.

After reading these recent studies, I suggest that teachers give eye tests after an intermission or play period in which the eye muscles have had a chance to relax. In this way, a more valid result may be obtained, particularly if a more complete device than the Snellen chart is used as a screening test for locating pupils with eye difficulties.

Glasses have been found to be very helpful in improving visual acuity, however. Eames made a study of 100 pupils who did need refractive errors corrected. They were given a complete ophthalmic examination both before and after glasses had been provided. Acuity at 20 feet and at the reading distance was checked.

With the glasses 81 percent of the pupils improved at one or both distances; 41 percent improved in vision at both distances; and 27 percent in near distance only. Thirteen percent improved in distant vision only, and 19 percent showed no improvement. These figures support the investigator's statements that glasses do not always improve vision.

Eames states the following reasons why some pupils improved and some did not:

A child with hyperopia can use his muscles of accommodation to focus correctly but "at the expense of excessive muscular energy." The myopic child, on the other hand, can see best at reading distance, and with glasses benefits most in vision at the far distance, Eames explains.

The same investigator made another study to discover the amount of hypermetropia or myopia that indicated a need for glasses, as shown by the effect of corrective lenses on the speed of visual perception with these two eye defects. One hundred pupils with these refractive errors were chosen from grades five through seven, and studied as to the speed of object and word perception both with and without glasses. The instrument used was a tachistoscopic one with a shutter having measured exposures from 1.000 to 0.0033 seconds in durations. Slides showed familiar objects and words.

The findings supported the criteria used by oculists known by Eames that lenses are usually prescribed for hypermetropia of 1.00 to 1.50 diopters or more and for 0.75 to 1.0 diopter of myopia.

The findings showed, moreover, that glasses helped in the speed of object and word perception in "an appreciable percentage of cases." Those with the highest refractive errors benefited most, and pupils with hypermetropia with little error benefited more than did pupils with the same degree of myopia.

Glasses were found to be more helpful in word perception than in object perception. Even those with the weakest lenses were helped, usually. But "glasses sometimes retard the speed of object and of word perception."

Eames believes that the decision for the

use of glasses is always an individual matter. He recommends that a pupil be given a tachistoscopic test for the speed of object and word perception at the time that his eyes are being examined by an oculist, particularly if the pupil is a reading failure and if he has such low refractive errors that glasses would not usually be recommended. With this information, the doctor can decide better about the use of glasses.

Such a short-exposure device as the one described could help teachers and school psychologists to test, later, the amount of visual help supplied by the glasses. Eames recommends that the glasses be removed for a few minutes before the test is administered and that they be put on for a short while before the test is regiven in order that the results of the two tests may be compared more accurately.

Although school officials can do nothing about recommending the use of glasses, it would seem that they may test their efficacy to some extent and encourage pupils who have glasses to use them consistently.

Although glasses should not be recommended universally for all pupils having eye defects, the use of lenses may prove to be helpful in educational success. With this idea in mind, Krous made a study of remedial-reading pupils who had been found to have eye defects. The parents of 14 pupils obtained visual assistance for their children for two years from professional eye doctors. The findings showed an "average gain of 10 I.Q. points," and an "average increment of 1.9 grades over a two-year period." Krous attributed the apparent gain in I.Q. to the fact that the pupils were able to read the tests better.

It is my opinion that this amount of gain is a significant one, since children who are remedial-reading cases often show less than 1.9 grades of improvement in two years.

Joslin, too, reports how the correction of eye difficulties can help educationally. She discussed a nonreader, a frail boy who had been successful in kindergarten and in the first grade before he had become poor in reading. He had subsequently developed a feeling of inferiority and had started to build up a defense against reading.

She reports that Dr. Eames discovered that the child had eye-muscle imbalance and lack of fusion. Letters in words were "reversed, out of line, omitted, or repeated." As corrective procedures, visual fusion was developed by prisms on lenses and by the use of eye-muscle exercises. Remedial-reading work followed.

As a result the boy became successful in high school and as a naval instructor in radio. He is described as "a successful, intelligent, kindly man" today, a fact that might not have been true if he had not had both visual and educational help when it was needed.

Although glasses may not always be recommended for correcting eye defects, according to the recent studies discussed, they seem to me to have been helpful in a large number of cases.

Implications of These Studies for Teaching

A few of the implications for teaching have been discussed with the reports of the studies, but others seem to be suggested by the research. It would seem that the teacher can do the following things to aid his pupils:

1. Test all pupils near the beginning of the year with both the Snellen chart and with another device. The Eames Eye Test or the Keystone Visual Survey with the telebinocular may be used by the teacher, or the Massachusetts Vision Test may be used by a technician.

2. Send home recommendations that certain pupils be tested by an oculist. If the family really cannot afford the test, perhaps arrangements can be made through the school authorities.

3. Recognize the fact that the eyes of young children in the primary grades are not fully developed and that they are likely to be hypermetropic.

4. Realize that hypermetropic eyes may accommodate to close work, but that this process causes strain.

5. Recognize signs of eyestrain:

Frowns while reading, holding the book or the head at odd angles in order to see; difficulty in seeing the blackboard even if it is in a good light without glare.

6. Encourage pupils for whom glasses have been provided to wear them consistently.

7. Realize that a child whose vision cannot be fully corrected with glasses needs special attention:

a. The use of large, soft pencils, large sheets of paper, and books with large print.

b. The privilege of sitting near blackboards or charts that are being used.

c. The privilege of resting his eyes by looking out of the window frequently to relax his muscles of accommodation.

d. The privilege of having other pupils read factual material to him if he is having eyestrain.

8. Realize that even a good reader's eyes need a chance to relax by looking at distant objects rather than at the printed page.

9. Realize that, while a myopic vision may not hinder reading at close range:

a. A pupil with myopia may need professional attention because the defect may otherwise become progressively worse.

b. The pupil with myopia needs the privilege of sitting near a blackboard which is being used or of going even nearer to it if he needs to do so.

10. Realize that glasses, however helpful to the eyes, will not be enough if a child needs remedial teaching. Visual perception needs more than a clear image on the retina.

11. Recognize the fact that a child of premature birth may still be less mature physically and intellectually than others of his apparent chronological age. Adjust the works to his needs.

12. Realize that fatigue may have an ultimate effect on a child's work, even if he seems to compensate for it by greater effort. Plan for short rest-periods between periods of study.

13. Arrange the best light and freedom from glare that the classroom can provide.

I believe that both the visual and the educational needs of the child may be more nearly supplied by the use of such practices as these.

Summary

In this report several recent studies of visual or eye defects have been discussed, as have their possible relationships to reading.

Hypermetropia and exophoria at the reading distance seemed to be the eye defects most commonly found in poor readers. Aniseikonia was significant in its effect on reading ability, although its incidence was not so high. Astigmatism did not show an important relationships to reading in the studies examined. Myopia did not affect the reading skill at the usual reading distance, although it would affect reading from the blackboard.

Although the studies did not prove that these defects had been the primary causes of the reading difficulties, the frequency of their occurrence among reading failures seems to make them significant as probable factors in the reading disability.

Implications for teaching have been suggested.

Conclusion

Although poor reading may be caused by several factors besides defective vision, in fairness to either the good reader or the poor one such defects should be located and corrected as promptly as possible. This help will be worthwhile if it serves only to relieve eyestrain and its accompanying tension. It may, however, change a child's whole life by making him successful in learning to read.

799 Montello Street (12).

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Ophthalmic Miniature

Gairloch, 15th Sept. 1925

Dear Mrs. Edwards

Do not rush to conclusions about your eyes. The number of people who get this alarm is quite large. The number of them in whom it comes to anything is very small. My mother, the least hypochondriacal of women, was at one time convinced that she was getting cataract; but it passed away harmlessly. If you have had much to do with drops you have probably seen a young dog's eye go white, and wasted much sympathy on it before it came right again, and you learnt that this is a common ocular trick with puppies. My own sight varies absurdly, especially as to my long sight. Sometimes I can see better without my long distance spectacles than with them. Sometimes the spectacles are indispensable. Even at reading distance I can sometimes tell the hour from my watch without glasses quite distinctly. Then again I can make out nothing without them.

I have known Christian Science converts discard spectacles successfully after using them for many years.

Anyhow, do not be misled to variations and aberrations, or even white films, which are transient and even common.

I hope to hear that your eyes are as right as eyes ever are.

ever

G.B.S.

(From the autograph collection of Dr. James W. Smith, New York.)

MANAGEMENT OF CONGENITAL OCCLUSION OF THE TEAR DUCT

FRITZ NELSON, M.D.
Colorado Springs, Colorado

Since there seems to be a considerable divergence of opinion as to the time and the various means of treating congenital occlusion of the tear duct the Colorado State Ophthalmological Society conducted an investigation among its members and among oculists of other Rocky Mountain States. Questionnaires were sent out and the returned answers were evaluated. The result was used as material for an extensive round-table discussion which was held at a meeting of the Colorado Ophthalmological Society at Colorado Springs, Colorado.*

The questionnaire asked the following questions:

1. At what age are babies most frequently referred to you by obstetricians, general practitioners, or pediatricians?
2. What in your opinion is the most favorable time for treatment?
3. What kind of treatment do you recommend primarily?
4. If the more conservative treatments are unsuccessful and probing seems to be unavoidable, what kind of probes do you use?
5. After probing do you irrigate the duct?
6. If you irrigate after probing how is that done?
7. What are the results obtained with your most favored method?

Twenty-eight questionnaires were returned. Discrepancies between the number of questionnaires returned and the number of answers can be explained by the fact that not all questions were answered. In reply to Question 1, 23 said that babies were most frequently referred during the first half-year of life; three, during the first month; two, later in life. Nineteen doctors regarded the first half-year as the most favorable period; six, the first month; two, later in life.

The primary treatment recommended by 13 was massage of the tear-sac region; three, irrigation; seven, probing. Most of the oculists who use probes prefer Bowman No. 1 or No. 2; two preferred other types. After probing the duct is routinely irrigated by eight; occasionally, by nine; never, by eight. Only two irrigate the pathways when the patient is in an upright position, all the others do it with the patient lying on his back.

One oculist, following Dr. Allan Greenwood's advice never to probe an infant's tear duct, simply instils a two-percent silver-nitrate solution into the conjunctival sac, with much better results than with probing.

Unfortunately only a small number answered Question 7. It seems significant, however, that those who reported final results had up to 50-percent recurrences when probing was not followed by irrigation; those who use irrigation occasionally had up to 20-percent recurrences, but none in the irrigated cases; the few who irrigate routinely never saw any recurrences.

The question of conservative against more radical procedures has been going on for many decades, and both standpoints have been emphasized by extremely competent and recognized authorities. I do not plan to compile again the ample literature covering this subject but want to refer only to two late publications by Cassady[1] and one by Kendig and Guerry.[2]

It is, of course, obvious that the advocates of both the strictly conservative and the more aggressive methods have good reason for the methods they use. But very often it happens that one method proves to be far superior when applied by one surgeon and inferior by another. Sometimes, a small difference in technique makes all the difference in the world as far as results are concerned. There is no doubt that even one unsatisfac-

* Presented before the Colorado Ophthalmological Society, September, 1952.

tory result obtained by a certain technique may discredit that technique.

I am in no position to judge the merits of repeated instillations of a silver-nitrate solution into the conjunctival sac. However, I am unable to visualize how such a solution, when it reaches the obstacle in the lower region of the lacrimal duct, after contact with tear fluid has converted it into an inert silver-chloride solution, could possibly remove a mechanical obstruction.

More than three decades of ophthalmic practice have shown me that the management of congenital obstructions in the lacrimal canal (most successful in my hand) is the following:

If an infant is brought to me before the end of the sixth week of life because one or both eyes are watering and mattering, I try first to establish the diagnosis of a congenital obstruction by pressing the blunt end of a glass rod into the fossa lacrimalis.

If pus or purulent mucus is seen escaping from the punctum into the conjunctival sac, the diagnosis is fairly well established. However, to make certain, I irrigate the tear sac with saline solution with a baby's head bent a little forward.

If no trace of pus or irrigation fluid appears in the nostril, even when considerable pressure is applied, I am sure that a complete obstruction is present. In that case it is very unlikely that conservative treatment will cure the ailment.

In some instances the pressure on the tear sac or the irrigation may break a membranous obstruction and render the pathway patent. Then, usually, no further treatment is necessary.

I was told by one of my colleagues that one of his daughters had an obstructed duct since birth. No treatment whatsoever was administered, and when the child was nine months old the obstacle disappeared spontaneously and the duct has stayed open ever since. However, since not even irrigation, which is definitely a diagnostic and as well as a therapeutic measure, was done, it cannot be certain whether, in this rare case, a small leakage in an obstructing membrane permitted a slow but insufficient drainage during those nine months and later, due to the massaging effect on the tear sac by the constant contraction of the orbicularis oculi muscle, became larger.

Infants up to the age of six weeks or even a little older can be subjected to irrigation and probing comparatively easily without general anesthesia. Their faces are usually not yet as fat as older infants' and the puncta are readily accessible. They are also easier to handle because they don't struggle as hard and usually forget about the whole procedure within a few minutes. Older infants routinely need general anesthesia, preferably a rather superficial and short ether anesthesia.

As soon as I am reasonably satisfied that massage and irrigation will not break the obstacle, I do not waste any more time but introduce a Bowman No. 1 or No. 2 probe and break the obstruction mechanically.

When the probe is passed into the nose, the wall of the tear duct is invariably injured to a certain extent often causing some bleeding into the lumen and sometimes into the nose. If that blood, insignificant as it may appear, is allowed to clot this may lead to a secondary obstruction. There will then be an invasion of fibroblasts and, since practically all obstructed tear sacs and ducts are already infected, an even tougher obstruction will result.

This explains the not too infrequent recurrences which have been reported. The way to avoid such an occurence is by routine irrigation of the duct. The irrigation should be done immediately after probing and should be repeated as long as even minute traces of blood appear in the irrigation fluid.

The patient's head should be bent slightly forward during irrigation so that the irrigated material is not swallowed but is drained into a glass bowl, held under the patient's nose. It can then be examined. This I regard as particularly important, although I

have been unable to find any reference to it in the available literature including the well-known textbooks on ophthalmic surgery.

There are several reasons for this procedure:

1. It does not seem proper to irrigate infectious or potentially infectious material down a patient's throat.

2. If an infant's infected tear sac and duct is irrigated in a lying-down position, pus that is usually loaded with pneumococci may be aspirated into the respiratory tract. This is dangerous, especially if the child is under general ether anesthesia.

3. If, when the contents of sac and duct are drained into the throat, there is some choking, the surgeon may interpret this as a sign that the tear pathways are now patent.

4. The only way to be sure the duct is patent after probing and to learn the bacteriology of the discharge is to catch the fluid drained through the nostrils in a container. This rule applies not only to cases in infants but also to those in adults.

Case reports

To illustrate the importance of this procedure I want to quote briefly the case of Mrs. L. E. H., aged 60 years, who came to me for extraction of advanced bilateral cataracts.

Irrigation of the tear ducts was performed. This is preoperative routine in all cases in which intraocular surgery is to be done. The left duct proved to be normal and clean. The right duct and sac, however, though perfectly patent, were filled with masses of thick, creamy pus containing quantities of pneumococci. It took 14 days of daily irrigations with penicillin to get the pathways reasonably clean.

The recovery after bilateral extraction was uneventful but, as a precaution, the right duct was irrigated daily during the period of hospitalization.

If this patient's tear canals had not been irrigated, or if irrigation had been done in a lying-down position, I am sure that the dangerous infection in the tear apparatus would have escaped my attention and the probable result would have been a severe panophthalmitis and loss of the right eye.

A second case which shows the importance of the rules already described is that of a child, Marilyn B., aged six years, who was brought to the office on April 19, 1952, with the history, as reported by the reliable and intelligent parents, that both eyes had been watering and mattering since birth.

They had been advised by the obstetrician who delivered the baby that a congenital occlusion of the tear ducts was present but that they should not take the child to an oculist before the age of five years. Following this advice, the child was taken to an experienced and skillful oculist at that age. After repeated irrigations, both sides were probed under general ether anesthesia. The hospital record shows that a No. 4 probe was passed easily and that, after probing, some blood appeared. Apparently the ducts were irrigated after probing but both parents insist that when the child was returned from surgery there was still profuse bleeding from both eyes and nostrils. There is no record of further irrigations following the probing. The ducts closed again shortly after and the child was treated with irrigations. Another operation, planned for April, 1952, was not performed due to the sudden death of the attending oculist.

The child was seen in my office on April 19, 1952. Tears and pus were streaming constantly over the child's face. Irrigation of the sacs revealed a large amount of pus in both sacs and no drainage into the nose. It was decided to clear up the infection before more drastic steps were taken.

First, irrigations with chloromycetin were given every other day. Then every third day. Then sulamyd solution (30 percent) was used until the sacs were clean. On May 21st, probing was performed under intravenous sodium pentothal anesthesia.

On the right side, the probe met immediate and strong resistance and two bony ob-

structions had to be broken with considerable force. On the left side, three bony obstructions had to be pierced before there was drainage into the nose. Again there was considerable bleeding from the puncta and the nostrils on both sides.

Irrigation was continued until bleeding stopped completely. It was repeated the same evening, again on three consecutive days, and later every third day.

The pathways stayed patent and no further probing was necessary. The drainage has been normal ever since and no inflammatory reaction has ever occurred.

Conclusions

Congenital obstructions of the tear duct always should be treated early, preferably before the end of the second month of life. Irrigation and probing can be performed easily at that age without general anesthesia.

Probing is necessary if such conservative methods as massage and irrigation fail to break the obstruction. Probing of an infant's tear canal is not difficult and not dangerous, provided the proper technique is applied.

Every probing of an infant's tear duct must be followed by thorough irrigation. Not a trace of blood should remain in the lumen and nostril. If bleeding is not stopped completely, organization, reinfection, and recurrence of the occlusion frequently occur.

Irrigation should be performed with the baby's head bent slightly forward. This is the only way to be certain that the pathways are absolutely clean and patent. Irrigation should be repeated until the surgeon is well satisfied that the pathway will stay open.

With this technique, I have not had a single case during the last 25 years in which a second probing became necessary. Even in the case of the six-year-old child reported herein, in which multiple bony obstructions had formed in both canals, a complete cure was obtained with a single probing followed by thorough irrigation to remove every trace of blood.

1121 North Tejon Street.

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Ophthalmic Miniature

I took, beginning in December 1879, instead of the solutions of borax, those of silver nitrate (1:40), which were syringed into the eyes soon after birth. Before the injections the eyes were carefully washed externally with a weak solution of salicylic acid. The children of diseased mothers, when treated in this fashion, remained without infection, while other children who were not treated prophylactically (because we had believed that the mothers were not diseased) did become infected, two of them rather seriously.

Carl F. S. Crédé,
Die Verhütung der Augentzündung der Neugeborenen, 1884.

IRIDESCENT CRYSTALS OF THE MACULA

Experimental study on rabbits

J. Lijó Pavía, M.D.
Buenos Aires, Argentina

(Translated by Ray K. Daily, M.D., *Houston, Texas*)

In my last communication* reference was made to four cases of iridescent crystals in the macula, presenting the following forms:

1. Foci with more or less sharply defined edges, covering and extending beyond the macula.

2. Conglomerations of crystals, not less than one half the size of the disc, not connected with each other, occupying the macula.

3. The entire macula filled with crystals, without any sharp demarcation.

This study deals with changes which involve small accumulations of iridescent crystals which may be present in the macula or other parts of the retina; these crystals do not aggregate into large foci or plaques.

Case reports

Of the numerous cases encountered, the following are reported as typical of each group:

Case 1

E. L., a woman, aged 32 years, complained of a slow progressive loss of vision and small subjective opacities which moved with the fixation movements. She had used glasses for 12 years.

Vision corrected with glasses was 0.3.

The fundus of each eye showed a parapapillary temporal staphyloma, marked diminution in the caliber of the retinal arterioles, and marked sclerosis of the choroidal vessels with atrophy of the pigment epithelium. Vitreous opacities were present.

In the right eye were three large vitreous opacities, elongated vertically and situated slightly external to the temporal border of the macula; further externally in a segment of the retina, 2.5 times the size of the disc horizontally and 2.0 times the size of the disc vertically, were seen numerous foci, punctiform, round, and confluent, with iridescent reflexes. Stereoscopic examination in monochromatic light (sodium light) localized them in the internal layers of the retina, between the blood vessels and behind them. Their distribution and size are illustrated in Figure 1.

It may be of interest to note that examination of the affected sector of the retina in pseudo-infrared light revealed a thickening of the pigment epithelium. A general examination revealed a blood cholesterol of 2.41 gm. percent. The patient was not seen again.

Case 2

A woman, aged 50 years, complained of irregular headache. She had worn glasses for seven years with vision corrected to normal.

Examination of the fundus revealed in each macula a number of round dots similar in size and appearance to those described in the first case, with the difference that here they were arranged in annular form, surrounding the borders of the macula. Outside of this, the fundus presented a picture of arteriosclerosis grade 2,† in a reversible stage.

The general examination revealed a blood sugar 1.30 percent, and cholesterol, 2.10 gm. percent. The general blood pressure was 160/90 mm. Hg, and the disastolic retinal arterial blood pressure was 60 mm. Hg; this pointed to the probability of a mild endo-

* See Am. J. Ophth., **36**:1416, 1953.

† Lijó Pavía, J.: See Am. J. Ophth., **35**:404 (Mar.) 1952.

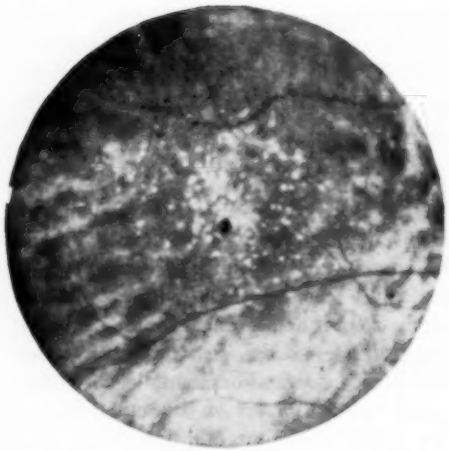

Fig. 1 (Lijó Pavía). *Case 1.* The lesion involves a sector of the retina situated just outside of the macula. Between the two blood vessels, which cross it horizontally, is seen in the center a black dot surrounded by numerous white foci, punctiform, round, some isolated and others confluent. The affected area is almost two disc diameters in size.

cranial hypertension, which accounted for the headaches.

Dr. Salomon prescribed for this patient a diet and thyroxin, which led to a subjective improvement extending over three years. At this examination, the patient still had normal vision but complained of a dizziness which was attributed to an esophoria; this was corrected by prisms. Her blood sugar was 0.90 percent and cholesterol, 1.80 gm. percent.

Hormones and vitamins B and C were added to the general therapy.

The macula of the right eye had a few iridescent points. They were barely visible in the left eye.

CASE 3

M.T., a man, age 44 years, showed hypertension, with a blood pressure of 185/95 mm. Hg. He complained of dizziness for three years, which at times was so severe that it caused him to fall and which produced severe headache. Corrected vision was 0.8 in the right eye and 0.9 in the left. Orthophoria.

The fundus presented a picture of advanced second grade arteriosclerosis. The maculas were surrounded by a ring of luminescent crystals, situated behind the internal limiting membrane, incomplete in the left eye, and complete in the right. There was incipient degeneration of the fovea.

The patient was referred to an internist, and returned for a re-examination six months later; at this time the blood pressure was 200/110 mm. Hg. The fundus showed no changes. The diastolic pressure in the central retinal artery was 65 mm. Hg, which indicated the advisability of hypotensive intravenous medication.

CASE 4

E. R., a young, woman, 19 years of age, seven months previously was treated for an attack of episcleritis by intravenous injections of calcium gluconate, vitamin C, vitamin D, and Cinnogyl. At this time she was referred because of impairment of visual acuity, which was 0.2, and fundus changes. The macula of the left eye and the retina somewhat beyond it, were covered with nu-

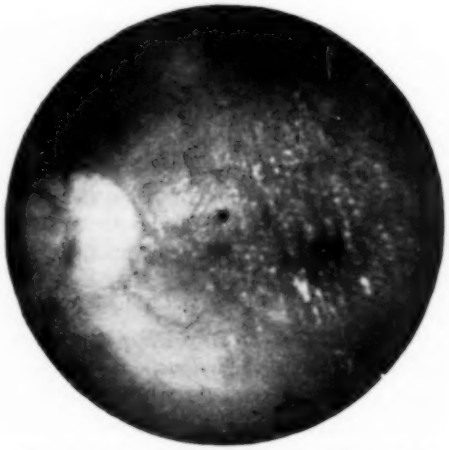

Fig. 2 (Lijó Pavía). *Case 4.* Posterior pole of the right eye. The papilla is on the left. On the right are numerous white dots, round, punctiform, and confluent, occupying the macula, and extended about one disc diameter beyond it. In the upper portion is a round, whitish, hazy patch. This is a perivascular focus, surrounding a branch of the superior macular arteriole.

merous shining, rainbow-colored foci of various sizes, punctiform, round, and confluent, situated behind the limitans interna. The retinograph (fig. 2) which is not very good because of the technical difficulties of photographing this nervous patient, nevertheless shows the distribution of the foci, and extent of the involved retina. At one disc-diameter distance from the upper pole of the papilla is a focus one fourth the size of the disc, surrounding the upper macular arteriole, interrupting the course of the corresponding venule which is markedly compressed.

Summary

1. In three cases, the affected region was the macula and, in one, the retina slightly temporal to the macula.

2. In Cases 1 and 4, the extent of the affected areas was equal.

3. In two cases, the distribution of the crystalline deposits was annular in form.

4. In all four cases the crystalline deposits were in the internal layers of the retina.

5. In two cases there was hypercholesteremia.

Comments

It is interesting to refer to the literature for important signs of differential diagnosis. In Bietti's[1] important work, Case 15 presents an interesting aspect, which Bietti classifies as "progressive macular degeneration." The patient was 33 years of age, and had normal vision in each eye. The optic discs were normal, and the maculas were surrounded by numerous whitish dots, much smaller in size than those described in my cases. Over a period of observation of two years, the patient held his visual acuity and there was slight progression of the lesions.

Müller[2] described a case of small, shining, golden-brown foci in the macula, situated in the innermost layers of the retina. Vision was 0.2. The lesions disappeared five and one-half years later. The presence of a copper stain in the cornea and the history of trauma made easy the diagnosis in this case.

In the work of Adrogue and Tetamanti,[3] Retinograph 215 illustrates a case of punctiform retinitis albescens, in which the foci are larger in size than those in my case, and had no iridescent reflexes.

I would also like to refer to my own former publications, in which I described dots, foci, and plaques in the macula and other parts of the retina consisting of cholesterol.

In an article by Adrogue and Lijó Pavia[4] is described in Case 9 a chorioretinal atrophic focus, situated in the macula and surrounded by a ring of small patches of cholesterol. This examination was made with the biomicroscope and a contact lens.

Crystalline deposits have been seen by me most frequently in hypertensive retinopathy. Among the published cases are those of:

A woman, aged 49 years, with cholesteremia of 3.9 gm. percent. Vision in the left eye was 0.9, and a large brilliant focus was present in the retina.[5] A woman, aged 41 years, with a visual acuity of 0.9 in the right eye, and a white focus with brilliant stripes in the macula[6] A patient, aged 67 years, with a visual acuity of 0.9 in the right eye, and shining dots of cholesterol and small foci of capillaritis. The blood cholesterol was 2.20 gm. percent.[7] A man, aged 45 years, with large masses of cholesterol in the retinal periphery, at 12 disc diameters distance from the macula in the form of brilliant nodules, the scintillating character of which was demonstrated by panoramic retinography.[8]

I have also encountered these dots in a case of severe ocular injury, iridocyclitis, traumatic cataract, and total disinsertion of the iris. Following cataract extraction vision was 0.6. An examination of the fundus revealed the presence of small iridescent dots. In a black and white retinograph they appeared as white foci; in color retinography they show polychromatism. The difference in the distribution of these dots is significant; as published in 1937, the foci in this case were situated in front of the limitans interna, as demonstrated by retinography.

These foci persisted for three months and were not seen after two years. Vision increased to 0.9.[9]

Experimental work on rabbits

The objective of this investigation was to determine if it is possible to produce experimentally the formation of these foci or dots in the retina. This work was done with the assistance of Roche Laboratories, and I take this opportunity to express my appreciation for their assistance. The administration of Cholesterin raised the blood cholesterol of the rabbit and produced white foci in the macula; the administration of thyroxin diminished the blood cholesterol and led to a retrogression of the lipid changes in the retina.

The results of this study coincide with the data of Salvati[10] on dogs, who also was able to produce changes in the fundus following the administration of cholesterol. In two dogs in which he alternated the administration of cholesterol with two-percent iodine, fundus changes were not produced.

Av. Quintana 104.

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QUANTITATIVE MEASUREMENTS OF VISUAL FIELDS FOR COLORS

With a direct-current method*

Yasuhiro Arakawa, M.D.
Sendai, Japan

Introduction

Traquair[1] pictured the visual field as "an island of vision surrounded by a sea of blindness." The visual field in the clinical test made with the Ferree-Rand perimeter corresponds to the coast line of this imaginary island.

It seems desirable that more work be devoted to the study of the interior of the island rather than to the study of its coast line. However, it is difficult to obtain reliable and reproducible data with the routine method of perimetry because of a great number of factors influencing retinal sensitivity to colors, as pointed out by a series of previous workers.[2-14] How much more so with quantitative measurements of regional variations in the color sensitivity of the retina!

Some attempts have been made to map the color sensitivity of the whole extent of the retina with the usual threshold method by Wentworth,[10] by Ferree and Rand,[9] and by Mayer,[15,16] with the method of flicker-fusion frequency by Creed and Ruch,[17] by Miles,[18,19] and Riddell.[20]

Motokawa[21,22] has introduced a new method into the study of color vision. Since this method makes use of a direct current for stimulation of the eye, it is called "the D.C. method." In the present investigation retinal responses to four kinds of spectral lights—red, yellow, green, and blue—were measured with the D.C. method over the

* From the Physiological Laboratory of Prof. K. Motokawa, Tohoku University

whole extent of the retina to obtain three-dimensional color fields.

Method

Motokawa's method consists in measuring the electrical sensitivity of the dark-adapted eye after exposure to colored light, taking the least perceptible phosphene as an index. When red, yellow, green, and blue lights are used for illumination, the electrical sensitivity of the eye generally rises after an illumination following a brief resting period, reaches a maximum in 1, 1.5, 2, and 3 seconds, respectively, and gradually returns to the previous level.

As has been established by the experiments of Motokawa[21-23] and of Oikawa,[24] the crest time or the time from the end of the pre-illumination to the crest of electrical excitability is characteristic of the retinal receptor involved, but depends neither on the intensity and duration of the light used nor on the retinal area illuminated.

Based on this fact, the interval between the light and the electrical stimulus was fixed at 1, 1.5, 2, and 3 seconds in the present investigation to determine the maximal responses of the red, yellow, green, and blue receptors respectively.

The responses were expressed quantitatively by a term ζ which is defined by the formula: $\zeta = 100\,(E - E_o)/E_o$, where E and E_o represent electrical sensitivity determined with and without pre-illumination.

This quantity may be employed as a measure for retinal excitation, because it varies in proportion to the logarithm of the intensity of the light used for pre-illumination in a considerably wide range of intensities, as was shown by Motokawa[21] and by Motokawa and Iwama.[25] In the present investigation the distribution of ζ was determined over the entire extent of the retina with the four kinds of test lights.

The target used was a circular disc of ground glass one cm. in diameter illuminated from behind by spectral light from a spectroscope. The distance of the target from the eye was always 30 cm. so that the angle subtended by it at the eye was two degrees.

For systematic variations of retinal location, a fixation point consisting of a minute red light was moved in steps of 10 degrees along the perimeter arc, while the target remained fixed.

The energy of spectral lights was made equal to one another by adjusting the width of the collimator slit of the spectroscope to the prescribed values computed from the known spectral energy distribution of the light source.

The intensity of the red light of 650 mμ was 70 times as high as the threshold intensity for the same kind of light at the dark-adapted fovea, and this intensity level was of the same order as the standard intensity for clinical perimetry.

The procedure of determination of ζ values will now be described in some detail, for it depends solely upon this procedure whether reproducible data are obtained or not. For one value of ζ two threshold values are needed, one determined with and the other determined without pre-illumination.

After a preliminary dark adaptation of about 20 minutes, a direct current pulse of 0.1 second in duration was applied through a pair of silver electrodes, 2.0 by 1.5 cm.^{2} in size, one placed slightly above the eyebrow and the other on the homolateral temple of the subject.

The voltage was reduced step by step from a level high enough to elicit a distinct phosphene until the subject could no longer distinguish the stimulus from one far below the threshold. The comparison of two stimuli, one above and the other below the threshold was absolutely necessary for obtaining reproducible values of threshold. In our experiments such a stimulating procedure was repeated 20 to 40 times in order to obtain one value of threshold. Trials were made at an interval of about 10 to 15 seconds, and about 20 values of threshold were determined in one session.

Threshold values depend upon various

physical and physiologic factors, as was shown by Motokawa,[22] but ζ values depend so little upon these factors that they could well be reproduced in different sessions.

For the reasons stated in the papers by Motokawa and Ebe[20] and by Motokawa et al.,[27] the duration of each illumination was always four seconds. This length illumination was necessary to avoid the masking effect of the scotopic receptor upon the photopic processes. The electrical threshold following an illumination was measured in the same manner as stated above.

The accuracy of our measurements was such that a difference greater than two in ζ values was usually significant. When temporal variations of threshold were found so great or so abrupt owing to sweating or some other changes that ζ values seemed scarcely free from such effects, the data were discarded, and the measurement could not be continued further till a steady-state was restored.

The first thing to be borne in mind in the application of the D.C. method is that, in the retina, there are many kinds of receptors having different electrical thresholds.

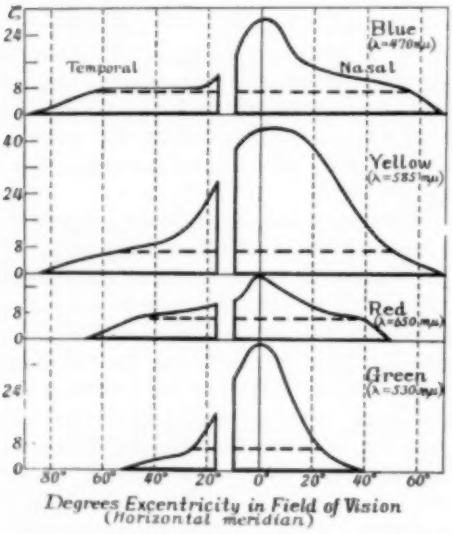

Fig. 1 (Arakawa). Distribution of ζ along horizontal meridian of left human eye. Broken lines represent major diameters of visual fields determined by usual perimetric method.

One might suppose that the lowest one among those thresholds is obtained by our experimental procedure, but in reality it is not always true; sometimes, for unknown reasons, not only the lowest threshold but also higher ones are revealed by this measuring procedure.

When we work with stimulating voltages graded in sufficiently small steps, we reach a threshold at which we cannot distinguish the threshold stimulus from one far below the threshold. If trials are made with a voltage reduced a little further, then, strange to say, sometimes a distinct phosphene appears again and continues to appear in further trials with further reduced voltages, and thus we reach the second threshold.

At a certain stage intermediate between the first and the second threshold a paradoxic phenomenon can take place so that the subject sees a phosphene in response to a weaker stimulus rather than to a stronger one. Therefore, it is necessary to reduce further the voltage to obtain correct answers when the subject gives wrong answers in succession.

In such a way we can confirm that there are multiple electrical thresholds in the retina. If any one unaware of this situation happens to encounter one of these multiple thresholds on one occasion and another on another occasion, he may believe that reproducibility is very unsatisfactory. To avoid such misunderstanding and to obtain reproducible results, one should always take only those threshold values which are certain to be the lowest ones obtained under a given experimental condition. Therefore, it should be a rule to carry out further trials after having reached a threshold to see if it is the lowest one.

For the same reason one should be cautious of taking the rough average of threshold values because they may belong to different populations; one should take the average only when it has been verified by

scrupulous measurements that they are really the lowest values.

Results

Throughout the following experiments the interval between the end of pre-illumination and the electrical stimulus was fixed at 1, 1.5, 2, and 3 seconds for red, yellow, green, and blue lights, respectively.

The distributions of ζ values for the four kinds of spectral lights measured along the horizontal meridian are shown in Figure 1. In every case, the value is highest in the fovea, decreases first abruptly then more slowly toward the periphery, and falls again more abruptly in the farthest periphery where the decrease begins usually after the ζ value has fallen to a level of from 6 to 8.

The extent of each visual color field as measured by the usual perimetric method is shown by a broken line in Figure 1. It is to be noted that both ends of the broken line corresponding to the peripheral edge of the color field just coincide with the point at which the second abrupt decrease of ζ begins.

Outside this point, no proper sensation of color is aroused by the given colored light;

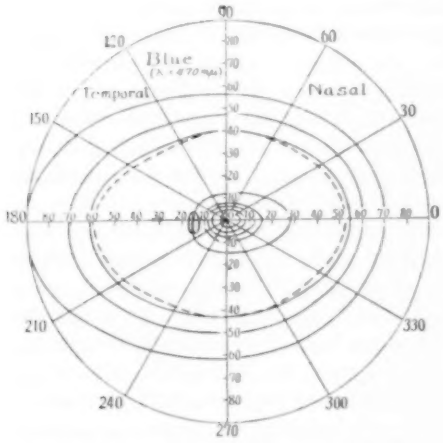

Fig. 2 (Arakawa). Isopters for blue light drawn at an interval of four in ζ units. Usual perimetric field, represented by broken line, coincides fairly well with the isopter at ζ level of 8.

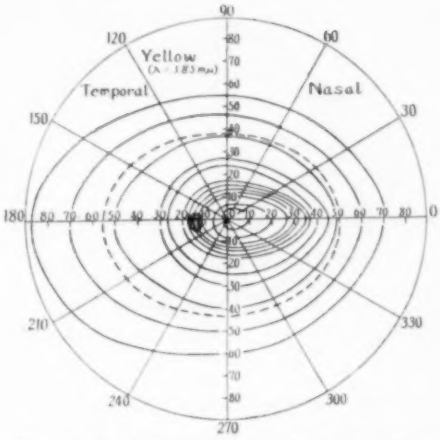

Fig. 3 (Arakawa). Isopters for yellow light. Usual perimetric field for yellow light is represented by broken line.

red appears orange; green, yellowish-green; yellow, gray; and blue, dark gray. It should be noted that, in the subliminal zone where sensations aroused are dichromatic or achromatic, ζ values are always lower than 8, irrespective of the kind of receptor involved.

The retinal excitation responsible for the proper color sensation is represented by each cone-shaped diagram above the broken line in Figure 1. The diagram for the yellow receptor encloses the greatest area, that for the red receptor the smallest, and those for the blue and the green receptors are intermediate in size. Such aspects of the color field cannot be revealed by the routine method of perimetry.

Similar measurements were carried out along other meridians, and a number of isopters or lines conducting equal values of ζ were drawn at an interval of four in ζ units on perimetric charts. Diagrams for blue, yellow, red, and green lights are shown in Figures 2, 3, 4, and 5, respectively.

The isopters represented by broken lines in these diagrams are the contour lines of the visual fields determined by the usual perimetric method. In all cases, the broken lines coincide fairly well with the isopters corresponding to the critical ζ value of from 6 to 8 mentioned above.

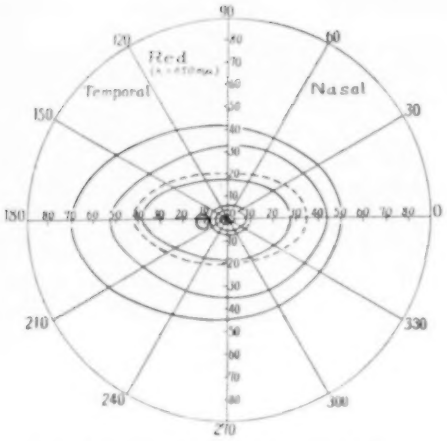

Fig. 4 (Arakawa). Isopters for red light.

As is well known, the ordinary perimetric fields extend much farther on the temporal side than on the nasal. Our isopters show the same property in the far peripheries, but the reverse eccentricity is found in the more central periphery and in the parafoveal regions, that is, the extension is greater on the nasal side than on the temporal.

In Figure 6, sets of diagrams consisting of isopters for the four kinds of tests lights at various levels of ζ are illustrated. At the ζ level of 32 there can be seen only two isopters which belong to the yellow and the

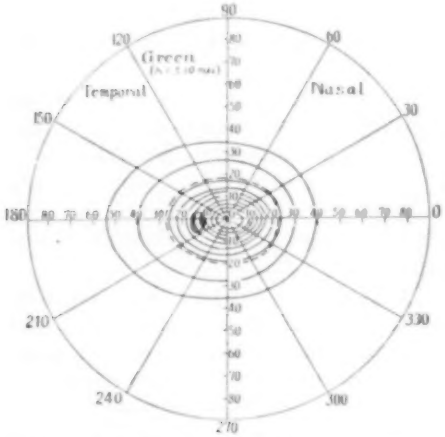

Fig. 5 (Arakawa). Isopters for green light.

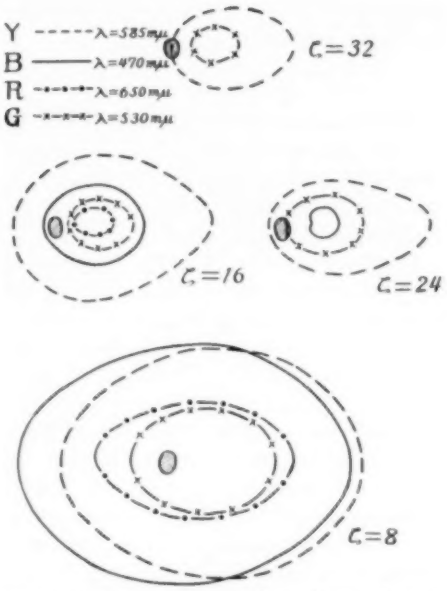

Fig. 6 (Arakawa). Isopters for various colors at varying ζ levels.

green receptor (see the top diagram). The other kinds of receptor do not show such high values of ζ at the intensity of light used and contribute nothing to this diagram.

At the ζ level of 24, three isopters are seen, whose extension is greater in the order: yellow > green > blue. The isopter for red makes its appearance for the first time in a diagram at the ζ level of 16. The set of isopters at the ζ level of 8 serves as a substitute for the color fields determined by the standard perimetry for the reasons already stated.

It is to be noted that interlacing or crisscrossing of the isopters for yellow and blue is found in this diagram just as in some perimetric fields obtained by previous investigators such as Wentworth.[10] According to this author, this is a rather general phenomenon, when the intensities of the stimuli used are approximately equal to one another, although it is claimed by Bull, Hess, Hegg, and Baird that the contour lines of the two color fields under consideration should co-

incide with each other under such experimental conditions.

In Figure 7, a bird's eye view of the visual field for yellow is presented. The horizontal parallels in this solid model represent isopters drawn at an interval of four in ζ units. In general, this model looks like a straw hat whose brim corresponds to the subliminal zone showing ζ values smaller than 8. The boundary line between the brim and the other part of the hat corresponds to the outer limit of the ordinary color field. The model may also be compared to a floating mountain of ice, whose part lying under the sea would be comparable to the subliminal zone stated above.

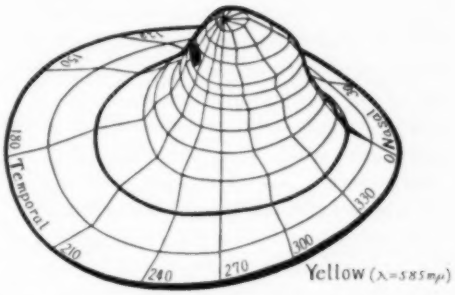

Fig. 7 (Arakawa). Bird's eye view of visual field for yellow light as determined by D.C. method.

Discussion

It is no easy matter to determine the color threshold in the extreme periphery where the prevailing rod process lowers the saturation of color. In our experiments, however, such disturbances due to simultaneous excitation of the cones and rods are excluded, because the rod process is suppressed by the use of a sufficiently long pre-illumination, and in consequence the cone processes alone are measured by our direct-current method. Judgment of hues requires more subjective efforts than does perception of an electrical phosphene.

Various phenomena of vision established by the D.C. method in human subjects have been reproduced in animal experiments in which the action potentials of optic nerve or spike potentials picked up by a microelectrode inserted into the retina were taken as the index, instead of the electrical phosphene in the human experiments.[28-31] This situation suggests that, with the D.C. method, we are measuring the processes in the retina itself.

In our method, each kind of cone process is isolated, using the time constant characteristic of each process. The usefulness of this principle can be seen in the fact that any result obtained by this method never contradicts the well-established facts of color vision, for example, the isopters at the level of ζ 8 are in good agreement with the well-established perimetric data.

The well-known dominant role played by the yellow receptor in the parafovea and in the midperiphery is exemplified by the fact that ζ values for the yellow test light are higher than those for any other kind of light in these regions of the retina.

The excitation of the blue receptor is not so high as that of the yellow receptor in these regions, but it decreases so slowly toward the periphery that it remains high enough to be a counterpart to yellow excitation in the peripheral dichromatic zone.

The clear-cut results reported herein are due to the satisfactory reproducibility of electrical thresholds in my subjects and to the high selectivity of our method. Such selectivity is lacking in the method of fusion frequency of flicker, although this method and ours have something in common in the use of physiologic quantities proportional to the logarithm of the intensity of light. In consequence, results obtained by the flicker method are generally much more irregular and more difficult to interpret.[17-20]

Summary

Motokawa's direct current method offers a serviceable means to map out three-dimensional color fields, instead of the two-dimensional ones determined by the usual perimetric method. In the D.C. method the electrical sensitivity is measured at dif-

ferent times after cessation of an illumination for different colors. Increases in electrical excitability are expressed in percentage of the resting level and denoted by ζ.

2. ζ values were determined along six meridians with four spectral lights of equal energy, red (650 mμ), yellow (585 mμ), green (530 mμ), and blue (470 mμ).

At the center and in the midperiphery of the retina ζ values were found higher for yellow and green lights than for red and blue lights. The value for green decreased very abruptly toward the periphery, while that for blue showed the slowest decrease.

3. Isopters or lines conducting equal ζ values were drawn on perimetric charts. The isopters corresponding to a ζ value 6 to 8 coincided with the contour lines of the usual perimetric fields.

4. The isopters were found oval in shape and extended farther on the temporal side than on the nasal, as in the usual perimetric fields, but they showed the reverse eccentricity in the parafovea and midperiphery of the retina.

Tohoku University.

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CHRONOLOGY OF PTERYGIUM THERAPY*

J. William Rosenthal, M.D.
New Orleans, Louisiana

Early records

The first recorded studies of pterygium date to the time (before 1000 B.C.) of Susruta, the world's first surgeon-ophthalmologist. Subsequently the condition was described by Celsus (50 A.D.), Vagblat (3rd-4th century), Paul (660 A.D.), Rhazes (932 A.D.), Avicenna (1037 A.D.), Chakradatta (1060 A.D.), and others.

Susruta's operative procedure is described:

With the patient recumbent on an operating table, the pterygium is loosened and disturbed by sprinkling powdered salt into the eye. The pterygium is then fomented with the palm, heated by rubbing with the finger. With the patient looking laterally, a sharp hook is used to secure the growth at its loosened upturned part, and is held up with a toothed forceps, or a threaded needle is to be passed from below the part which would be held up with the thread.

The pterygium is then gotten rid of by scratching it with a sharp round-topped instrument. The root of the pterygium should be pushed asunder from the black outline (cornea) of the eye to the medial canthus and then excised and removed. Any remnant of the pterygium after excision should be removed with a scarifying ointment.

Celsus's procedure (Rome—50 A.D.) consisted of raising the membrane with a sharp bent hook and passing a needle and thread beneath it. The thread was used with a sawing motion to separate the pterygium from the ocular tissues toward the pupil, then toward the medial canthus. The flap of tissue remaining was excised near the medial canthus with a scalpel.

Paul's operation (Paulus Aegineta, Eye Surgeon, Greece, 7th century): With a small hook the pterygium is seized and with a needle with a horse hair and strong flax thread in its eye, it is transfixed through the middle. With the thread, the growth is raised, and with the horse hair, it is sawed off the globe centrally. At the medial canthus, it is cut off with a scalpel.

Aetius (Greece) describes the same operation as Paulus Aegineta, as does Albucasis. Haly Abbas recommends the use of the scissors, not of the scalpel. Avicenna (Greece, 980-1036 A.D.) also recommends use of the scissors. Al Rhazes (Arabia ?-932 A.D.) and Jesu Hali performed the operation, as did Celsus, with scissors or scalpel.

Chakradatta's method (India, 1060 A.D.):

* This is one section of a thesis submitted to the faculty of the Graduate School of Medicine of the University of Pennsylvania, toward the requirements for the degree of Master of Science (M.Sc. [Med.]) for graduate work in ophthalmology.

If the pterygium extends to the pupil, the membrane should be lifted by the point of a needle, transfixed by a hook, and, leaving the pupil free, is to be excised by the round topped instrument.

All of these operations are just variations of Susruta's original work.

Medical treatment

Later efforts to treat pterygium were medical in nature. As none of the original manuscripts were available to me, information had to be borrowed. Therefore, a monograph by Dr. Merigot de Teigny and Dr. Coirre is quoted:

"The old writers said that pterygium, as nearly all other eye diseases, was improved by cabbage and pomegranate.

"In the Hippocratic collection we have the precise prescriptions of collyrium of lead, zinc, copper, iron, the bile, the urine, women's milk, each serving in turn as excipients.

"Celsus proposed blending mixtures: white wine and vinegar, water of Euphrasia, and candied sugar, nitrated fennel water.

"Saint-Yves used copper sulfate. Maitre Jean used a complicated collyrium: one scruple of cuttle-fish bone, half a scruple of powdered crystal, 15 grains of white vitriol, half a drachm of Florentine iris, one drachm of candied sugar; a few grains applied three or four times a day on the pterygium. He also used the same collyrium under a powder form.

"Mare, in 1780, mixed powdered alum and sugar candy and made with it scarifications.

"Middlemoore used an astringent collyrium; Mackensie, silver nitrate and lead acetate. Deconde applied a lead acid, which did not succeed, says Foucher, in 1860. Becker and Mannhardt had recourse to atropin to cicatrize the ulcer. Ruelle, in 1889, quotes a patient, who, after 35 days living in the atmosphere of a tanning factory, was cured, but the collyrium of the products of the tannery did not benefit. Desmarres says that the red salves are without effect. Darier extols mercuric lanoline which was at that time in favor.

"Many actually point out interesting results obtained by such treatment: It is probable that the cases told of had an additional conjunctival irritation. The collyriums most used were: sulfate of zinc, of copper, and of alum.

"Villard recites, as does the majority of writers, that there is no very efficacious medical treatment, advises isotonic solutions, and sulfate of zinc. Veray regards the need of operation as exceptional for he obtained beneficial results from sulfate of zinc, 0.5-percent, with adrenalin. Even well-advanced cases appear to him to remain stationary under this treatment.

"Lofruscio advises after the operation: Crook's glasses and the following collyrium: Sulfate of zinc, 3 centigrammes; hyposulfite of soda, 2 centigrammes; boric acid, 15 centigrammes; sulfite of adrenalin at o/o, 5 drops; distilled water, 10 grammes.

"Orfali-Bey advises two-percent sulfate of zinc and calomel salve.

"Darrigade injected in the thickness of the pterygium one drop of a solution of perchloride of iron and sulfate of zinc or of silver nitrate.

"Gonin had recourse to a subpterygial injection of sublimate at 1/2,000. This process used on four or five cases of recurring pterygium has the advantage of bringing about a union of the conjunctiva 'pterygionnante.'"

Surgical procedures

Following and during the use of medical therapy, various surgical procedures were advocated from time to time. Many authors wrote of the dangers of the procedures, and advised temporizing as long as vision was not impaired. Others would operate only if the cornea was invaded, or if the patient was "esthetically tormented."

Some were cynical about surgery. Ambroise Pare stated: "You will learn from Cel-

sus that this disease always recurs, even when you have done all in your power to cure it."

Despite this attitude, surgical therapy fluorished, as evidenced by the following almost interminable chronicle of procedures:

In brief review Celsus (Rome, 1 A.D.) separated the pterygium from the cornea with a scalpel, after lifting it from the sclera by a thread passed beneath. Aetius and Paul of Aegineta sawed it from its attachments with a horsehair. Heister made a vertical incision through it as did Saint-Yves, who also pulled the flaps away. Acrel (1771) cut through the growth on the cornea and was the first to advise and practice total removal of the head and to circumscribe it with the bistoury. Richter removed only the tip of the pterygium head.

Early 19th century operations

Scarpa (1802) removed the head from the cornea with forceps, dissected backward to a point three to four mm. from the limbus, where he excised the freed portion by an incision concentric to the limbus. This same operation was performed by Lawrence in 1830, Wharton Jones in 1863, and Abadie in 1876.

Travers (London, 1805) insisted that none of the pterygium be removed from the cornea, as Scarpa declared that excess scarring would cause exotropia. Others to perform this procedure are Westhoff, Peterquin, Pellier de Opinsy, and Rubio. According to Merigot de Treigny and Coirre, however, Wharton Jones, Abadie, and Lawrence practiced Acrel's old procedure of 1771.

Benjamin Bell, in 1813, recommended scarification of the pterygium in a direction parallel to its long side. Cauterization and scarification, after separation, were also practiced by Woolhouse and Beer.

It is interesting to note that one of the more modern writers (Kamel) has found cauterization an important method of therapy—reviving a technique abandoned more than a century ago.

Other chemical cauterizations that have been used are the chromic acid of Grandelement, the carbonic snow of McCallan, and the silver nitrate of Ajily-Bay-Haydar.

Probably the first to use conjunctival sutures to cover the exposed sclera was Coccius, thus credited by Arlt who himself deserves the credit (according to Fuchs) for having made the operation for pterygium a success. He (Arlt) demonstrated the necessity of closing the conjunctival wound. On the other hand, Fox gives the credit to Funo (Fano).

Transfixing the neck of the pterygium by means of a thread, followed by cutting the corneal attachment and base of the growth, with its subsequent extirpation, was practiced by Weller, in 1832, and Walton, in 1853.

In 1842, the method of ligation was introduced by Szokalski. Meyer, in 1888, Lagrange, and Barlan, in 1901, were also in favor of this procedure:

Three sutures were passed beneath the pterygium; one at the limbus, one at the base, and a double one in the center. The inner and outer sutures were tightened and tied. The double suture was first used to pull the growth from its scleral attachments, then tightened and the ends fastened to the cheek with collodion. The pterygium "died" about the third day and was excised. The method is condemned by Shoemaker.

Shaugnessy (1848) cured one case of pterygium by application of nitric acid.

Arlt (1850) used an excision technique, removing a rhomboid of tissue, and closing in a cruciate manner. A. Pagenstecher used the same procedure as did Barny de Romanet.

About 1855, the elder Desmarres devised the method of transplantation for the purpose of diverting the growth from the cornea. The pterygium was detached from the cornea and sutured into the adjacent lower fornix of the conjunctiva. It was found that the pterygium atrophied after transplantation; thus Desmarres established a principle used in all transplantation operations.

In the Desmarres operation, after the head of the pterygium has been lifted from the cornea, equal incisions are made along the upper and lower borders and one obliquely inferiorly and temporally from the end of the lower incision. The pterygium is either tucked under the conjunctiva below or sutured in the inferior cul-de-sac. The small conjunctival flap is then sutured upward between the pterygium and corneal margin.

Terrien's modification employs the tucking procedure and bringing of the flap upward.

Knapp's operation (1868) is more or less a refinement of Desmarres and is applicable especially to pterygia with broad heads. Knapp removed the head from the cornea, split the pterygium in two longitudinally and incised along its upper and lower borders. From the ends of these incisions, oblique incisions are made in the conjunctiva above and below. The two parts of the pterygium are then sutured superiorly and inferiorly, as conjunctival flaps, or sutured deep to the conjunctiva, in Terrien's modification. Finally, the quadrilateral conjunctival flaps are sutured together at the limbus. Odaiva modified Knapp's procedure.

Klein, in 1876, described the use of mucous membrane grafts in those cases of pterygium removal where it is impossible to leave sufficient bulbar conjunctiva to cover the defect. Pollet (1906) redescribed the same type procedure for use with primary operating as did Gifford (1909), Cozalis (1920), Duverger (1926), Green (1937), and Dosorova (1942).

In 1880, Galezowski used a technique described three years before by Numar (Palma), whereby he freed the head, neck, and body of the pterygium, doubled the growth on itself (raw surfaces together), and sutured the head to the base. The free conjunctival edges were then brought together with sutures. The same procedure was described by Bettman in 1894 in an article entitled "Subvolution. A new pterygium operation." DeWecker used an identical operation, as did Falce (1906-18) and Wing (1911).

In 1918, the procedure was again described as a new procedure by Alexander. He, however, occasionally resected the head, and let the conjunctival defect remain. Finally, in 1948, Rosen described the technique and improved it by suturing together the conjunctival edges that remained, covering the denuded area.

Late 19th century operations

In 1885, Prince accidentally detached a pterygium from the cornea with a muscle hook, with a successful result and this later was adopted as the method of choice (for relieving the corneal attachment) by Prince, L. R. Dibble, and others.

Also, in 1885, Boeckman first described his operation of reposition and fixation. The pterygium head is cut from the cornea, limbus, and a little beyond. The head is resected. The growth is allowed to retract, and the subconjunctival tissue dissected and excised for several millimeters nasal to the cut edge of the pterygium neck. The conjunctival flap thus freed is sutured to the insertion of the medial (or lateral) rectus muscle with a single suture. The defect is left to epithelize itself.

Wright, in 1888, experienced the same accident as Prince did three years before. He, too, adopted this evulsion as a surgical procedure, but also ligated the base and excised all tissue to the ligature. He recorded the case of a patient who cured himself by pulling his own pterygia from his cornea with "eye tweezers," without anesthesia, and with excellent results.

Hobby introduced an ingenious operation in 1888. The conjunctiva is incised along the upper border of the pterygium and an incision at right angles to this is made upward, at the limbus. The pterygium is separated from the cornea and the vertical incision continued a bit below the lower border of the pterygium, which itself is incised to its base and cut off. The upper conjunctival

flap is then undermined, pulled down, and sutured to the lower flap.

Elschnig used a similar procedure, employing excision and covering of the defect with a pedicle conjunctival flap graft.

Alt, in 1889, used Arlt's procedure, but cauterized the bare limbus and cornea with pure carbolic acid.

A simple procedure was described in 1890 by Boston (after Kennedy). The pterygium head is cut from the cornea and limbus. A suture is placed above and below in the cut edges of the conjunctiva about one mm. from its limbal attachment. This suture is then tied beneath the head of the growth causing it to pucker. The whole mound of tissue thus made is excised with a single bite of the scissors, and one conjunctival suture is placed between the first suture and the pterygium base.

In 1892, Hotz used the Thiersh grafts in pterygium operations and reported his results.

Gifford used this graft in recurrent pterygium procedures. Autoplasties with free fragments of conjunctiva were used by de Gama Pinto, Gomez-Marques, and de Paula Xavier.

H. Knapp (in Norris and Oliver) reports on an operation in 1894 by Schuleck of Budapest, saying that it is the same as that of Arlt. With that I cannot agree. Knapp's description of the procedure follows:

The pterygium is detached and allowed to lie in the inner canthus after having closed the episcleral defect with sutures. In order to prevent the conjunctiva, when sutured, from overlapping the cornea, a horizontal incision is made above and below, into the corneal edge of the conjunctiva.

However, Fox states that "Pagenstecker and DeWecker detached the growth in every portion except the base, which was allowed to atrophy. The conjunctiva above and below was dissected freely, and united by sutures."

It is evident that the operations of Arlt and Schuleck are different. Which procedure was used by Pagenstecher (or Pagenstecker) is not known.

Hobbs (1894) introduced the use of the galvanocautery (52 volts) for cutting across the pterygium neck and also for cauterizing the head if the latter was large.

Czermak (1896) obtains the same result by passing the needle next to the cornea, not only through the conjunctiva but also through the superficial scleral layers.

Coe (1896), and later Loring, strongly advocated the use of the actual cautery (heated platinum wire) to destroy the head and neck of the pterygium. It was used as an office procedure, the lower half being cauterized first. This had been advocated previously by Martin in 1881.

The weak galvanic current (2.0 to 5.0 ma.) had been tried by Hobbs and reported on favorably by Sharkey (1898).

Mackenzie's method (quoting Fox) of operation consisted of raising the growth by grasping its center with forceps and excising by one sweep of the scissors. The ends were then trimmed neatly and the wound edges approximated by sutures. Deval used this procedure but used a suture instead of forceps for elevating the growth. Panas (from Fox) extirpated the pterygium and cauterized its point of corneal attachment by the actual cautery.

Early 20th century operations

McReynolds (1902) modified Desmarres' operative technique of transplantation and began the use of an operation which is, to this day, the most popular of all. He removed the head wholly from the cornea, then incised medially along the pterygium border above and for a longer distance below. The pterygium was then freed to its base. The conjunctiva below was undermined.

A double-armed mattress suture was placed through the pterygium head and the needles were then passed into the conjunctival pocket below, and out near the inferior cul-de-sac. The suture was tightened, pulling

the pterygium into the conjunctival pocket, and tied, holding the pterygium in place.

In 1904, Fox described a transplantation operation similar to the last one described, but the incisions along the pterygium borders extended down to the base. After the growth had been sutured under the conjunctiva, he pulled the free conjunctival edges over the pterygium and sutured them in place.

Following his dissertation upon the etiology of pterygium, in 1905, Shastid recommends "injecting the canalis pterygialis with mild antiseptic solution." He also designed a procedure consisting of cauterization of the "pterygium tunnel" with carbolic acid, excision of the head and neck to the scleral side of the limbus, and cauterization of the latter with carbolic acid.

P. Lipscomb of Texas (according to Shoemaker) has devised an operation of excision with the cicatrix placed so as to reduce recurrences. The head, neck, and body of the pterygium are freed and the growth cut off at its base. The conjunctiva above and below is undermined. An incision is made in the conjunctiva below at the inner canthus, concentric to the limbus. An incision is also made above, at the limbus. Sutures are then placed at the apices of the conjunctival flaps, the one above being sutured below and vice versa.

Shoemaker also describes a procedure by G. Edgar Dean, of Pennsylvania, who, after freeing the pterygium from tip to base, covers the conjunctival defect. A loop of a galvanocautery snare is then thrown over the pterygium mass, which is actually burned off at its base.

Hawley (1911) noted his method of the skin grafting operation for pterygium. The pterygium head, neck, and part of the body are resected. A superficial, thin graft from the skin behind the ear, on the thigh, and so forth is taken and sutured onto the conjunctival defect at the limbus with two sutures. Hawley reaffirmed his devotion to this procedure in 1937.

Morax and Magitot, in 1911, tried the use of artificially preserved homografts from the corneas of fetuses and adults. These operations were, in general, successful; only a few recurrences were reported.

Probably the first reference to radiation therapy for pterygium was made by Terson (Paris, 1911), as an afterthought. He described his operation as consisting of removing the head and cutting out a rectangle of the body of the pterygium tangent to the limbus. Then he incised the normal conjunctiva vertically below in two places, corresponding to the sides of the rectangle and forming a flap which he brought up with sutures to cover the denuded area. The denuded cornea was curetted and cauterized with the galvanocautery.

For the large invading pterygia, if electrolysis and fibrinolysin have been unsuccessful, Terson recommends trying radiotherapy, especially radium; if this fails, a plastic operation should be done. From Terson's laissez-faire attitude, I judge that radium had been used previously to treat pterygium, but with equivocal results.

White published the description of an operation, in 1911, which was much like that of McReynolds and Lipscomb. The pterygium is removed and transplanted as in the former procedure. The conjunctiva is circumcised from the limbus from the upper pterygium border to the 12-o'clock position and the nearby conjunctiva undermined. This flap is then brought down and sutured to the free conjunctival edge below to cover the bare sclera. An incision tangent to the limbus may be made below to free the lower conjunctiva so that it fits snugly against the limbus.

Beard, in 1914, used a conjunctival plastic operation for pterygium removal:

The neck is cut across and the head dissected from the cornea. Two parallel, almost horizontal, incisions are made within the pterygium body from the limbus to the base. The part of the body so outlined is dissected up and pushed toward the caruncle quite

firmly. There are two parallel incisions made vertically, one tangenital to the limbus at the neck and the other at the border of the retracted body, cutting through conjunctiva above and below, and forming flaps when dissected up. The corners of these are sutured together, the suture including the pterygium body nasally.

Prince (1916) announced the favorable results he had in treating pterygium with carbon-dioxide snow. He used it in reducing the vascularity of the growth, but states that operation to remove remaining tissue on the cornea may have to be done.

Goldenburg's modification of the McReynolds procedure was published in 1922. Instead of bringing the suture out and tying it in the lower cul-de-sac, Goldenburg brings the needles out through the skin of the lid, below the tarsus.

The operation of Dr. Lazlo Blaskovicz (1922-1926) consists of freeing up the pterygium entirely, then removing the head. A suture is inserted so as to roll the growth upon itself in the medial canthus. Blaskovicz left the denuded areas to granulate in, but I have modified the procedure by undermining the conjunctival edges and approximating them with two sutures.

A satisfactory resection operation was described in 1922 by Campodonico. He dissects the head, neck, and body of the pterygium from the cornea and sclera, and excises the growth at the base with scissors. The conjunctival edges are approximated with two sutures. The suture insertion near the limbus should be through the conjunctiva and episcleral tissue so that the flap is drawn upward.

The year Campodonica's technique was described, Crigler described a similar type operation where the growth is excised partially, and the upper flap sutured to the lower. This is quite like Hobby's procedure.

The Kassel technique (from Spaeth) achieves the same results as the latter two procedures by destroying the growing blood vessels and connective tissue fibers.

In discussing the repair of pseudopterygia, Francis (1922) described his procedure of totally dissecting up the growth, splitting it horizontally, and burying it above and below in a pocket beneath the lids by a suture going through the lid. The bare area is covered by approximating the free conjunctival edges.

Ziegler, in 1922, going on the theory that pterygium is a cicatricial subconjunctival growth, described the following procedure:

The head of the growth is shaved from the cornea, and the neck and body undermined, incisions being made above and below at the pterygium borders. The subconjunctival tissue is then dissected off the conjunctiva covering the pterygium and excised. The apex of conjunctiva remaining is excised and the free conjunctiva allowed to retract into the inner canthus. The defect remaining is closed by sliding the conjunctival edges together and suturing them; the suture nearest the cornea being anchored in episclera. Liberating incisions can be made to allow more freedom of the flaps if the defect is large.

Whitmire (1925) used a procedure whereby he resected the pterygium head, incised the conjunctiva above and below near the limbus, undermined the conjunctiva above and below and allowed it to slide up and down postoperatively, freeing any posterior adhesions with a probe under the flaps for several days postoperatively.

Elschnig (1926) published a procedure for recurrent pterygium whereby the head, neck, and partial body were resected. A conjunctival bridge from the opposite limbus was then brought across the cornea to cover the defect.

It was in 1926 that Spaeth described his rotated island graft for pterygium. This procedure is especially good for large and recurrent pterygia, or when there is some limitation of conjunctiva already present.

Spaeth removes the head of the pterygium from the cornea by tearing with a silk suture and curettes off any remaining tissue.

Four incisions are then made, forming a square, with one side at the pterygium base, the opposite tangential to the cornea.

Sutures are placed in the corners of this square island of conjunctiva and subconjunctiva and brought through corners of the defect 90 degrees away. These sutures are now tightened and tied, effectively rotating the whole square 90 degrees, with the head pointing upward and the base down. The sutures nearest the cornea are anchored so that the former lower conjunctival edge is just tangential to the limbus. Additional sutures on the sides of the square may be inserted as necessary.

Also, in 1926, Bistis described an operation he calls scleropexia. The pterygium is completely freed by dissection, then sutured to the sclera above and the defect closed.

Bucky in 1927 (to quote Reeves) used X-ray therapy for the ablation of pterygia.

Pochissoff, in 1930, reviewed his technique for pterygium transplant, which is similar to that of Campodonico and Crigler. He removes the pterygium head, neck, and upper body from the cornea and sclera and excises it. Then, by undermining the conjunctiva below, brings the two free conjunctival edges together with sutures.

In the same year, Finnoff reported excellent results in curing one case of fleshy recurrent pterygium by applications of the thermophore at 138°F. once every three weeks for a year.

Mendoza recommended, in 1931, his procedure for recurrent pterygium, consisting of loosening the head and neck, undermining the body, and anchoring the pterygia several millimeters from the limbus by an episcleral suture. This he also uses as a primary operation.

In 1931, Zubak described a method of removing pterygia by electrocoagulation, just as Coe did with the actual cautery in 1896. Shahan used heat from a thermophore for the same purpose.

Also, in 1931, Fazakas published an operation for pterygium, whereby he repositioned the plica semilunaris; and Mata reviewed his method of excising a pterygium and covering the area with buccal mucous membrane.

Spaeth's original technique was modified, in 1932, by Blott, who rotated the island of tissue 180 degrees, instead of 90 degrees, facing the head toward the inner canthus and the base at the limbus.

The technique was further modified by Shainfein, in 1934, who transplants the split corneal apex subconjunctivally at the canthal incision.

In 1934, Duchan cured a pterygium by cauterizing the neck of the growth several times with copper sulfate, at weekly intervals. Kaminskaja (1935) described Beard's (1914) procedure for pterygium removal as a new operation for recurrent pterygium.

An operation modifying that of Desmarres, and closely resembling that of McReynolds, was discussed by Turner, in 1936.

A diathermal coagulation type therapy for pterygium was described in 1936 by Amorin.

A slightly different technique for removal was described by Arruga in 1937. The pterygium is completely excised. He makes a large pedicle flap above the limbus and slides it into the defect suturing it to the conjunctiva below and the limbus above.

A totally different technique was also described in 1937 by Dimitry. He injected the pterygium stroma with iodized oil, then severed the head and removed it from the cornea. The oil, he said, would make the growth shrink.

Miller described, in 1937, an operation which modified, in certain details only, the original transplantation of Desmarres.

Busacca modified the McReynolds technique in 1938. He dissected the pterygium up fully and dissected off and excised the subconjunctival tissue. A small vertical incision was then made at the base of the growth to allow the head to come well under the conjunctival flap (made as by McReynolds). The bare juxtacorneal area was cauterized with picric acid.

An operation for pterygium much like

that of McReynolds was described in 1939 by Neber who, however, transplants the pterygium upward, as does Berens.

Recent operations

Burnam and Neill, in 1940, described their use of the Burnam radon applicator (originally made in 1927) for pterygia and other conditions. Since then, Ruedemann, Iliff, Swanberg, Hughes, and others have described their use of radium, radon, and beta irradiation as therapeutic agents for pterygia.

A procedure much like Lipscomb's, except using the pterygium itself as a conjunctival flap, was brought out in 1942 by Stocker.

Also in 1942, Torres-Estrada described his personal technique for pterygium operation, which is much like Lipscomb's old procedure. The former, however, excises subconjunctivally the hypertrophied episcleral tissue.

Kirby (1943) brought forth another type of electrosurgical pterygium excision. The pterygium is completely dissected up from head to base, and a needle with high frequency electric current is used to puncture the base along a vertical line at the base. The growth is then cut off along this line. The free conjunctival edges are brought together, with the help of limbal incisions if necessary.

Bangerter (1943) has a procedure similar to that of Campodonico. He, however, resects the growth entirely, leaving a V-shaped defect. He then incises the conjunctiva above or below, at the limbus, undermines the conjunctiva extensively and slides the flap upward into the inverted V (or downward into the V) formed by the pterygium resection.

Dimitry, in 1944, described putting solid choline chloride in the head of pterygia, causing the blood vessels to become engorged, with disappearance of the fatty substances in the growth.

In the same year, Gurley redescribed McReynolds' method of transplanting pterygia.

The idea of Morax and Magitot (resecting the pterygium followed by keratoplasty) was reintroduced by Reis in 1945. He uses a modified McReynolds procedure. However, he resects a large amount of cornea with the head, and replaces the corneal defect with a piece of clear cornea from a donor eye. This piece is held in place with a conjunctival flap.

Staz, in 1945, described his modification of the McReynolds procedure. He performs the classical operation and then, from the conjunctiva at the edge of the conjunctival pocket, he forms a narrow flap which he swings upward between the pterygium and limbus and sutures in place.

Svoboda reported (in 1946) of his use of Denig's method of buccal mucosal implantation in pterygium operations.

Kamel's much-used procedure, described in 1946, consists of complete dissection of the pterygium from the cornea and sclera, and incision of the upper and lower borders to the base. It is allowed to fall back and any part redundant upon the cornea is resected. The underside of the growth is then cauterized with carbolic acid. No sutures are used.

Another modification of the McReynolds procedure was recorded by Goldsmith in 1947. He made a conjunctival incision concentric to the limbus, over the depths of the conjunctival pocket and communicating with it. The sutures were passed through this opening, then through the episclera below so that the growth was held tightly. The same suture was used to close the extra conjunctival incision.

Also in 1946, Tagle published a technique of pterygium operation whereby the whole growth was excised and the defect covered by a graft obtained from the conjunctiva along the superior limbus. The latter and the graft were held in place by suitable sutures.

McGavic in 1949 described a procedure for recurrent pterygia which consists of dissecting the growth free and excising it. The

conjunctival edges are then undermined and sutured to the sclera and the area is allowed to re-epithelize, much as in Sugar's method.

Down through history there were many who practiced and reported upon various operative techniques without making any outstanding contributions. They number in the hundreds and their names may be found in the literature of all nations and all ages. And so it appears that for about 30 centuries man has tried to conquer this little growth called pterygium.

It has been incised, removed, split, transplanted, excised, cauterized, grafted, inverted, galvanized, heated, dissected, rotated, coagulated, repositioned, and irradiated.

It has been analyzed statistically, geographically, etiologically, microscopically, and chemically—yet it grows onward primarily and secondarily. We look with interest to its future.

3615 Prytania Street (15).

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Ophthalmic Miniature

These four cases serve well to illustrate the connexion between certain eye-symptoms and a diseased condition of the spinal cord. In all of them there was marked contraction of the pupil, which differed from myosis due to other causes, in that the pupil was insensible to light, but contracted still further during the act of accommodation for near objects, while strong solutions of atropine only induced a medium dilatation of the pupil.

Douglas Argyll Robertson, 1869.

NOTES, CASES, INSTRUMENTS

SUBCONJUNCTIVAL CORTISONE IN IRIS-INCLUSION SURGERY

GEORGE J. WYMAN, M.D., AND E. E. HOLLINGSHEAD, D.V.M.
Peoria, Illinois

Since one of the effects of cortisone is to inhibit the production of fibroplastic proliferation, it would seem to be indicated in any filtering operation for glaucoma, where fibrous tissue is especially undesirable. We have been using cortisone drops topically following iris inclusion with no noticeable effect. Having used cortisone subconjunctivally for various eye conditions it was thought worth while to run a controlled experiment on dogs. The following experiment was then performed.

ANIMAL EXPERIMENT

Four puppies, weighing about five pounds each, were anesthetized with intravenous nembutal. A conjunctival flap was dissected down to the limbus and the anterior chamber entered with a keratome.

The iris was pulled out, a portion cut off, and the remaining iris pillar was left in the wound. The conjunctiva was sutured with a running 5-0 plain gut suture. Identical operations were done on all of the eyes.

At the completion of the procedure, the right eye of each dog received a subconjunctival injection of cortisone containing 25 mg. per cc. The usual amount injected was about 0.3 of a cc.

Every two or three days thereafter, under topical anesthesia, an injection of cortisone solution was made with a fine needle under the flap in the right eyes, and the results observed. The dogs were killed at two, four, six, and eight weeks and both eyes were removed for sectioning.

Unfortunately, the eyes were excised with considerable neighboring tissue and cellodion fixation was not good. As a result the sections had to be switched to paraffin and final sections were so distorted that they were of no value. Hence, only clinical observations will be recorded.

Without exception all the eyes receiving the cortisone injections were more congested and showed more corneal edema than the controls. This is at variance with the idea of inhibition of inflammatory reaction by the drug.

At the end of the 10 days, three of the eyes had an open wound as evidenced by the solution leaking from it and in one eye this persisted for three weeks. The haziness of the cornea vanished by the end of the first five days in all of the injected eyes.

At two weeks, when the first dog was killed, the cortisone-treated eye had a firm adherent mass at the operative site with the inclusion area itself not well demarcated. The control eye on the contrary had a clean iris prolapse with a slight bleb.

By the fourth week, when the second dog was killed, the treated eye had a firm nodule at the site of the surgery and considerable scarring of the conjunctiva about it so that on injection of the solution it was difficult to get into the immediate area. The next four weeks only made the findings more evident, as the untreated eyes, although not showing active filtering scars, had clean prolapses covered with conjunctiva and a minimum of reaction or new vessels. The treated eyes, on the contrary, had much new scar tissue, adherence of conjunctiva to sclera, and new vessels.

CONCLUSION

As a result of using subconjunctival cortisone after iris-inclusion operations in dogs, the amount of vascularization and fibrous tissue proliferation in the treated eyes was definitely and without exception much more marked than the control eyes. Subconjunctival cortisone would appear contraindicated after any type of filtering operation.

744 Jefferson Building (2).

Acknowledgement is made to Merck & Company who contributed the Cortone in the experiment.

PROCEDURE TO PREVENT VITREOUS LOSS

H. J. Flieringa, M.D.
Rotterdam, Holland

During recent years, chemotherapeutic agents and antibiotics have reduced postoperative infections to a minimum, while akinesia and retrobulbar injection of anesthetics have lessened the risk in operations on the eyeball. However, loss of vitreous continues to be a menace in intraocular operations and may, even if the operation is technically well performed, cause the loss of the eye in complicated cases. It is therefore no wonder that, in view of this risk, many surgeons prefer not to operate on such eyes.

Among the techniques devised to avoid the serious complication of a profuse loss of vitreous is the method described by Prof. van der Hoeve of Leyden, by which four sutures are placed in the sclera between the limbus and the insertion of the recti muscles. An attempt is made to prevent, by the pull exerted upon these so-called van der Hoeve sutures, loss of vitreous after the opening of the eyeball.

Although these sutures do, to a certain degree, prevent collapse of the eyeball, they cannot guard against loss of the shape of the globe, the consequence of which will be a diminution of the surface and loss of vitreous. It will be clear that, as soon as the pull placed on the sutures by assistants becomes too high, the diminution of the contents may become considerable and that, consequently, this aid may prove to be a disadvantage rather than an advantage.

In order to prevent vitreous loss, I have used, since 1946, a procedure which, some years ago, I communicated to the Netherlands Ophthalmological Society and by which I have achieved results so satisfactory as to justify a further description.

Description of method

The principle of this method is to prevent collapse of the eyeball by reinforcing the sclera. It is achieved by fastening a metal ring around the sclera just as a hoop is fastened around a barrel. Experiments show that it is advisable to use a ring with a diameter of 20 mm. which should, in addition, be elastic, so as to keep its circular shape as completely as possible. It should also be thin in order not to hamper manipulations in the field of operation. It should, moreover be made of material which will not act as a chemical irritant. These conditions are fulfilled by a ring made of stainless steel which has a thickness of 0.3 mm.

The ring is so applied as to be concentric to the cornea. Provided the eyeball is of normal size, the distance between the ring and the limbus will thus be five mm. at every point. In a larger eyeball a ring with a diameter of 22 mm. should be used.

The ring is fastened in the following manner:

In eight places, equally distributed on the total circumference, the conjunctiva is incised and the sclera exposed. Next, at these eight points, the suture is brought through the superficial scleral layers and the ring is thus firmly attached to the sclera.

Alternate sutures are cut off close to the knot and kept long. These four long sutures enable the assistants to move the eyeball in whatever direction is desirable. It is equally possible, by accurate traction on these sutures, to retain the greatest possible amount of the contents of the opened eyeball.

Along the ring, after it has been put in its place, the conjunctiva is freed as far as the limbus and an ab externo incision is made in that part of the circumference of the eyeball which will make entrance to the interior most easy. In some cases the incision will extend over three fifths of the circumference.

A couple of loose scleral sutures (the exterior of the incision being situated in the sclera) are carried through before the eyeball is opened. By these, an assistant is able to pull the cornea upward so as to afford an adequate working space for the surgeon to

perform the necessary intraocular manipulations.

With this technique, there need be no fear of a disturbing amount of vitreous escaping even if it is mostly liquefied.

After the operation is finished, the sclera is firmly closed by a number of sutures over which the conjunctiva is carefully closed by suture.

I used to remove the ring immediately after finishing the operation, but I have since come to the conclusion that it is not only practicable but may often even be very useful to keep it in its place until the operative wound is firmly closed, usually in a week's time.

In operations of complicated cataract, especially if the vitreous is liquefied, in extracting a luxated lens, whether it is lying in the anterior chamber or has been dislocated into the vitreous, in cutting a hole into a strongly scarred iris diaphragm; in short, in all operations which present the risk of loss of vitreous, my method has proved to be of high value.

It need not be stressed that routine procedures such as akinesia of the orbicular and external eye muscles should always be used. In cases which offer exceptional risks and especially whenever a one-eyed patient is operated on, I start by severing the rectus muscles from the eyeball to attach them again after the eyeball is closed.

Schiedamsevest 80.

OPHTHAINE®

A NEW TOPICAL ANESTHETIC FOR THE EYE*

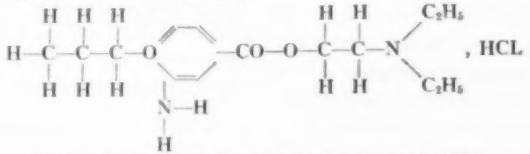
CHARLES W. BOOZAN, M.D., AND
IRWIN J. COHEN, M.D.
New York

Many local anesthetics have been employed in the eye. Of the present drugs available, Tetracaine (Pontocaine®) has gained the widest acceptance. It is most commonly used in 0.5- to 2.0-percent concentration, and affords adequate topical anesthesia. It is the purpose of this report to present a new topical anesthetic agent, Ophthaine®, created for use in the eye. It has been found superior in several ways to the other common topical agents.

The drug is freely soluble in water and dilute acids to yield a clear solution. It is not compatible with alkalis since the insoluble free base is liberated.

Ophthaine® was used in 0.25- and 0.5-percent concentrations in combination with 0.5-percent chlorbutanol in physiologic saline. Biologic assay for the toxicity of this drug revealed that, in the concentrations and amounts used in our tests, the drug is eminently safe.

Ophthaine® is an amorphous off white solid and has the empirical formula $C_{16}H_{27}N_2O_3$ Cl. Its molecular weight is 330.85 and has a structural formula



2-Diethylaminoethyl 3-amino-4-propoxybenzoate-HCL.

Ophthaine® was given prolonged clinical trial on the wards and in the clinics of New

* From the Department of Ophthalmology, New York University, Post Graduate Medical School. Funds and supplies of Ophthaine® for this work were provided by the Squibb Institute for Medical Research, E. R. Squibb & Sons, New York.

York University-Bellevue Medical Center. During the course of this trial, the anesthetic effects were observed in surgical operations, tonometry, removal of corneoscleral cataract sutures, and removal of foreign bodies of the cornea.

It was used as the preoperative anesthetic topical agent in 43 operations which included a wide variety of procedures, the majority of which were cataract extractions. In these, the drug was administered in a series, one drop topically administered every 10 minutes for five doses. On operation, it was noted that the anesthetic level was sufficient to permit any desired surgical manipulation.

The drug was also used for the removal of cataract sutures 12 to 14 days postoperatively, small amounts, one to two drops, being instilled in the eye two minutes before the removal of the sutures.

In our series of cases there has been no evidence of drug sensitivity, either local or systemic. It is of interest that where sensitivity has appeared with the use of other agents, Ophthaine® has been used with impunity.

Technique of evaluation

In order to evaluate the efficacy of this drug properly, several of its properties were compared to those of Tetracaine. One drop of Ophthaine® (0.5 percent) was instilled in the left eye of the subject and one drop of Tetracaine (0.5 percent) in the right eye. The drugs were compared for:

1. Time of onset of anesthesia.
2. Duration of anesthetic action.
3. The amount of conjunctival hyperemia.
4. Local and systemic toxic effects.
5. Pain on instillation.

The determinations of conjunctival hyperemia, local and systemic toxic effects, and pain on instillation were recorded in the accepted 0 to 4 plus scale.

The onset of action was measured from the time of instillation until the absence of the corneal reflex. Corneal sensitivity was tested with a wisp of cotton. The return of corneal sensitivity was determined in a similar manner, testing for the reappearance of the reflex every 30 seconds.

The time until onset of action with Tetracaine (0.5 percent) ranged from 9 to 26 seconds averaging 14.7 seconds while that of Ophthaine® (0.5 percent) ranged from 6 to 20 seconds with an average of 12.9 seconds.

The duration of action of Tetracaine (0.5 percent) was found to range from 9 to 22 minutes with an average duration of 14.9 minutes. The duration of action of Ophthaine® (0.5 percent) was 6 to 24 minutes with an average of 15.2 minutes.

The tendency for conjunctival hyperemia was identical in range for both drugs and averaged less than one plus for each. No local or systemic toxic side effects were noted with either agent. Pain on instillation ranged from 0 to 4 plus with an average value of 1.5 plus for Tetracaine (0.5 percent), while Ophthaine® (0.5 percent) ranged from 0 to 2 plus and had an average of less than 0.5 plus.

After instillation of the Ophthaine® (0.5 percent), there were no instances of pupillary dilatation and no cycloplegic effects could be demonstrated. There was considerably less stinging sensation and accompanying squeezing of the lids. This was in the ratio of approximately 1:4 of Ophthaine® over Tetracaine. It was not uncommon for the patient to remark that nothing had been placed in the eye. This is in contrast to the discomfort that patients experienced with the instillation of Tetracaine in the other eye.

Conclusion

1. Ophthaine®, a new drug for use as a topical anesthetic in the eye, is presented.

2. A striking characteristic of Ophthaine® is its pronounced decrease in stinging or pain on instillation in comparison with 0.5-percent Tetracaine.

3. It was compared with Tetracaine in equal concentration and found as potent,

equal in rapidity of onset and duration of action.

4. During a period of extended clinical trial this drug has been found to be a safe and potent anesthetic agent.

SULFADIMETINE (ELKOSIN) IN OPHTHALMOLOGY*

PAUL HURWITZ, M.D.
Chicago, Illinois

Elkosin† (N^1 (2,6-dimethyl-4-pyrimidyl)-sulfanilamide) is a heterocyclically substituted sulfonamide. In its synthesis, numerous five- and six-membered rings were used as substituents. Small changes of the substituents may cause a marked increase or decrease in efficacy. For this reason, unpredicted results in this field of chemotherapy are always possible.

Elkosin, extensively used as an antibacterial agent, has a wide therapeutic range. It is highly effective against pneumomocci, meningococci, coli bacilli, streptococci, staphylococci, gonococci, B. proteus, and Pseudomonas aeruginosa. Taken orally, it is rapidly absorbed from the gastro-intestinal tract and excreted in the urine.

Elkosin is 0.3-percent soluble in water and is freely soluble in mineral acids and alkalis. There is minimal tendency to crystallize from saturated aqueous solution or the urine. Thus crystalluria, hematuria, and renal damage are not likely to occur. Ninety percent of the concentration of Elkosin in the blood and urine is in free form.

PRESENT STUDY

In an ophthalmic solution of normal saline, Elkosin is slightly soluble and must be prepared as a suspension. The ointment is prepared in a petrolatum base. Concentrations of one percent and five percent of both forms were experimentally used in a number of external ocular disease processes.

TABLE 1

TREATMENT WITH ONE-PERCENT ELKOSIN OINTMENT AND SUSPENSION

	Improved	Not Improved
Chronic conjunctivitis	20	7
Acute conjunctivitis	5	1
Subacute conjunctivitis	4	0
Chronic blepharoconjunctivitis	2	0
Hordeolum	1	0
TOTALS	32	8
Percentages	80%	20%

Sixty-six cases of infectious external ocular conditions were treated with one-percent and five-percent Elkosin. Forty cases were treated with the one-percent concentration, 12 cases with the ointment, and 28 cases with the suspension. There were 27 cases of chronic infectious conjunctivitis, 10 cases of acute and subacute infectious conjunctivitis, two cases of blepharoconjunctivis, and one case of hordeolum (table 1).

Eighty percent of the patients evidenced moderate or complete improvement with one-percent Elkosin. The suspension was somewhat more potent than the ointment. The therapeutic response was greatest in acute conjunctivitis and least in chronic, nonspecific conjunctivitis of mild degree.

Improvement was noted subjectively in most of the symptoms associated with conjunctivitis. In this series, these symptoms consisted of redness, discharge, agglutination of the lids, tearing, itching, burning, photophobia, and foreign-body sensation.

Objective improvement was determined by diminution or disappearance of conjunctival injection, diminished secretion, regression of follicular and granular hypertrophy, and elimination of angular excoriation, scales, and crusting.

Analysis (table 2) discloses that 50 percent of the treated cases were markedly improved, 20 percent, moderately, and 10 percent, mildly so. The remaining 20 percent

* From Mt. Sinai Hospital and Chicago Medical School, Chicago, Illinois.

† Supplied by CIBA Pharmaceutical Products, Inc., Summit, New Jersey.

TABLE 2

DEGREE OF IMPROVEMENT WITH ONE-PERCENT ELKOSIN

	Marked	Moderate	Mild	None
Acute conjunctivitis	5	0	0	1
Chronic conjunctivitis moderate	10	4	3	3
Chronic conjunctivitis mild	3	1	2	4
Subacute conjunctivitis	1	2	0	0
Blepharoconjunctivitis	0	1	1	0
Hordeolum	1	0	0	0
TOTALS	20	8	4	8
Percentages	50%	20%	10%	20%

were unaffected. The most dramatic response was encountered in the acute cases and occurred within three to eight days. In several cases, recurrence of the disease developed after treatment was terminated.

In many cases, instillation of one-percent Elkosin caused a slight burning sensation. One case resulted in doubtful allergic reaction to the drug.

Despite the apparently good therapeutic results with the use of one-percent Elkosin, it was considered possible that a higher concentration of the drug would be more efficacious.

A five-percent strength of Elkosin, in suspension and in ointment, was investigated; 26 cases of acute conjunctivitis, chronic conjunctivitis, and blepharoconjunctivitis were treated. There was a favorable reaction, either marked or moderate, in 23 cases.

As with one-percent Elkosin, the most noteworthy effects were manifested in acute conjunctivitis. All such cases were improved.

Less singular, though still salutary, was the progress obtained in chronic conjunctivitis. Blepharitis and blepharoconjunctivitis also responded well to treatment with five-percent Elkosin (table 3).

Eighty-eight percent of these cases were improved. Such a high percentage is considered exceptional for the local use of a chemotherapeutic agent in external ocular infections. Complete cure in the acute cases was achieved within two to four days. The majority of chronic cases were improved within seven to eight days.

Untoward reactions from five-percent Elkosin were no greater than with the one-percent concentration of the drug. The principal disadvantage of Elkosin is its limited solubility in an ophthalmic aqueous preparation. Suspended in solution, the drug necessitates thorough shaking prior to its instillation. The ointment has proved satisfactory.

TABLE 3

TREATMENT WITH FIVE-PERCENT OINTMENT AND SUSPENSION

	Improved		Not Improved
	Marked	Moderate	
Acute conjunctivitis	7	1	0
Chronic conjunctivitis	4	7	1
Blepharitis squamosa	0	2	1
Blepharoconjunctivitis	1	1	1
TOTALS	12	11	3
PERCENTAGES	46%	42%	12%
	88%		

Conclusions

Elkosin (sulfadimetine) in five-percent concentration is an excellent topical chemical bacteriostatic, or chemotherapeutic, agent. As an ophthalmic drug, it can be effectively used for the treatment of acute and chronic conjunctivitis and blepharoconjunctivitis. Other external ocular infections should respond favorably to treatment with Elkosin.

55 East Washington Street (2).

TRAUMATIC BITEMPORAL HEMIANOPIA*

Norman S. Jaffe, M.D.
Miami, Florida
and
Lloyd S. Durkin, Capt. (MC)
Fort Campbell, Kentucky

Of all the traumatic conditions producing visual field defects, injury to the optic chiasm is perhaps the least frequent. There are relatively few cases in the literature. The most sizable collection has been contributed by Traquair, Dott, and Russell,[1] who collected 27 cases and studied three carefully. Liebrecht[2] (1906), Cushing[3] (1930), and Hughes[4] (1943), among others, have also reported such cases.

The usual history is that of an injury to the front of the head, although temporal injuries occasionally cause bitemporal hemianopia. X-ray examination usually reveals a fracture of the sphenoid bone, although this is by no means the rule as pointed out by Traquair and his collaborators. The field defect may be immediate or late. Walsh[5] described a case where the bitemporal hemianopia occurred several years after the injury. The underlying pathologic condition is probably different in these cases. Later development of a visual field defect is probably due to the occurrence of posttraumatic adhesions.

It is not surprising that chiasmal injuries

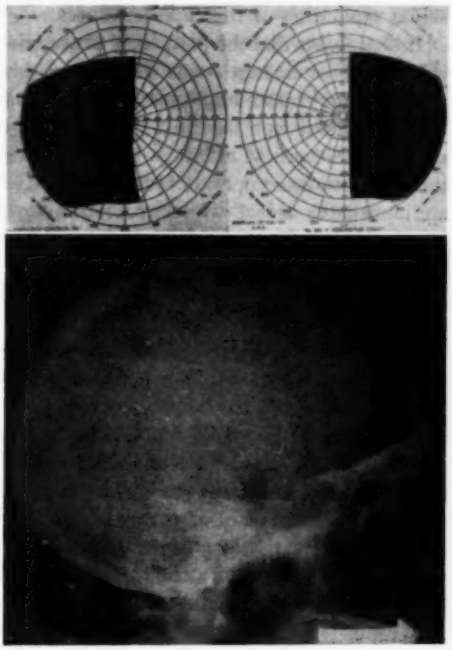


Fig. 1 (Jaffe and Durkin). Patient with fracture of sphenoid bone and bitemporal hemianopia.

are associated with other signs and symptoms. The close proximity of the chiasm to other vital structures, such as the pituitary gland and the hypothalamus, virtually assures the occurrence of diencephalic disturbances such as polydypsia, diabetes insipidus, drowsiness, and so forth. These signs are usually transient and probably result from hemorrhage and edema.

The exact pathologic process underlying traumatic chiasmal lesions is not clearly understood. Some suppose that there is an actual tear or bisection of the chiasmal fibers. Osterberg[6] showed that sagittal tears in the medial portion of the chiasm are easily obtained. He demonstrated this in the chiasm of an individual dead 12 hours. Others believe that the chiasmal fibers degenerate as a result of interruption of their blood supply. Traquair and his colleagues and Walsh are in agreement with this, although the latter believed that in some instances there may be

* From the Departments of Ophthalmology and Neurosurgery, U. S. Army Hospital, Fort Campbell, Kentucky.

actual separation of the chiasmal fibers.

It is probable that the pathologic process is variable. Hemorrhage with fibrosis in the region of the chiasm may cause a bitemporal hemianopia through the formation of adhesions. Here the field defect is late in occurrence. Actual interruption of fibers will cause an immediate defect while interruption of blood supply will cause an immediate or delayed defect.

Case report

A 23-year-old white soldier was in an automobile accident in Bermuda, May 5, 1951. His car collided head-on with a tree. He sustained a compound, depressed fracture of the frontal bone and was unconscious for the next six hours. X-ray studies at that time revealed a basal skull fracture extending through the greater wing of the sphenoid, on the right, and possibly through the midline. There was a simple comminuted fracture into the frontal sinus. Visual field studies revealed that the patient had a bitemporal hemianopia.

He was admitted to the U. S. Army Hospital, Fort Campbell, Kentucky, complaining of frontal headaches, diplopia, and inability to see things in either temporal field. He also complained of excessive thirst, inability to smell, and the secretion of excessive amounts of urine. There was a discharge from the nose. This was a clear fluid tinged with blood. At times the fluid was more bloody than others.

A diagnosis of cerebrospinal fluid fistula was made. On May 29th the fistula was repaired. The drainage ceased from the nose. He also claimed to have some improvement in vision. All other symptoms disappeared except for the anosmia.

Ophthalmologic examination on May 23, 1951, revealed a visual acuity of 20/20, right eye, and 20/40, uncorrectible, left eye. Extraocular muscles were normal. There was no diplopia. The ocular medias were clear and there was no pathologic finding in the fundus. Visual field examinations revealed an absolute bitemporal hemianopia. The field on the left included the macula and all vertical points above and below the macula. The field on the right spared the macula and points above and below the macula.

1345 North Bayshore Drive (32).

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PREANESTHETIC MEDICATION IN THE OCULAR SURGERY OF CHILDREN

H. D. Wright, M.D., and
C. E. Tetirick, M.D.
Columbus, Ohio

Several requirements must be met to carry out a satisfactory anesthetic procedure for the ocular surgery of children: (1) There must be the greatest inherent safety for young patients; (2) we must produce a field for operation satisfactory to the surgeon; (3) in the anesthetic management of children from the age of 15 months to four years, from which the results in this paper are presented, we are convinced that avoiding psychic trauma to the child, as well as to the parents, is an important factor; (4) following the performance of delicate eye surgery, it is desirable that the child have as quiet and uneventful postoperative recovery

period as possible, especially in the first few hours.

Procedure

In the procedure which we use, the child enters the hospital on the evening previous to the day of operation. This allows for the proper laboratory tests to be completed and examination of the patient by the various physicians concerned.

On the following morning a liquid breakfast is given, and then nothing further is given by mouth. Operation is usually scheduled four to five hours following the liquid breakfast. During the morning of the day of operation, a cleansing tap water enema is given so that the lower bowel may be free to retain the small amount of medication.

About one hour before operation, the prescribed amount of sodium pentobarbital dissolved in one ounce of tap water at body temperature is given rectally by a small urethral catheter. The child goes quietly to sleep, and one-half hour later the preanesthetic dose of atropine is given subcutaneously. One hour following the rectal administration the child goes to the operating room quietly asleep and with total unawareness of his surroundings.

Following the preanesthetic preparation, the induction and maintenance of anesthesia may be undertaken by whatever method the anesthetist prefers. We usually induce with vinethene oxygen or nitrous-oxide oxygen and maintain these patients on ether oxygen by oropharyngeal or nasopharyngeal insufflation.

These patients usually react to being placed on the operating table and to the induction of anesthesia by mildly moving a hand or foot, never to the extent of requiring manual or physical restraint. The great majority of these children do not realize that their operation has been done when they recover in their rooms. Quite naturally, all parents are very well pleased with the technique.

Advantages of this procedure

The use of barbiturate preanesthetic medication broadens the safety factor. The sudden tragic fatalities (which rarely occur) which are due to ventricular fibrillation in an epinephrine-sensitized heart, following a stormy induction in a terrified child should be eliminated. The use of vasoconstrictor drugs in local injections for hemostasis during ocular surgery, while not condoned by the anesthetists, would certainly be much safer in the child buffered with a barbiturate blood level.

According to Guedel* the amount of anesthetic necessary is directly proportional to the metabolic rate of the patient. Thus, by reducing the preanesthetic excitability and having a level of barbiturate in the blood, the metabolic demand for oxygen and nutrition is decreased and less total amount of general anesthetic is required.

The production of a satisfactory operative field for the surgeon is largely a matter of actual anesthetic management but is certainly facilitated by this preanesthetic medication technique.

Acknowledging some opinions to the contrary, we are convinced that psychic trauma of the child, as well as the parents, may result from careless preanesthetic management as the hour of surgery approaches. We believe that forcefully taking a screaming child from the arms of equally panicky parents and physically restraining him on the operating table should be relegated to the Dark Ages.

The advantages of having a child go quietly to sleep in bed with the parents by the bedside should be obvious. This is of even greater importance when the child may face a repeat procedure of the same nature, where it is a great advantage to all concerned to leave child and parents with as pleasant memories as possible.

A quiet and uneventful postoperative recovery period is always welcomed by the ophthalmologist following ocular surgery.

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* Guedel, A. E.: Inhalation Anesthesia. New York, McMillan, 1951, Chap. 5.

Such a state is facilitated by this preanesthetic medication procedure. Enough residual barbiturate is present so that, following the return from surgery and emergence from the anesthetized state, our small patients drift into a quiet sleep for several hours.

Barbiturate dosage

The dosage of sodium pentobarbital is proportioned to the age and weight of the patient. In children, between the ages of 15 months and two years, we employ 2.0 gr. of sodium pentobarbital, providing the child's weight is a minimum of 20 pounds and not over 30 pounds. In children between the ages of two and four years, ranging in weight from 30 to 50 pounds, we employ 3.0 gr. of sodium pentobarbital.

This dosage scale is a relative proportion since the prescribed dosage for a given patient is the result of an individual evaluation of that child by his doctors. Thus, an emotionally unstable child of two years, weighing 30 pounds might fare better on 2.5 gr. of sodium pentobarbital than just 2.0 gr. To the present time we have not employed this procedure in children over four years of age and in those weighing over 50 pounds.

One's first impression might be that the barbiturate dosage used is rather sizable for these young patients. However, again referring to Guedel, we realize that a child's metabolic rate is the highest at the age of six years of any time during his life. Factors of emotional excitement and operative pain also increase the basal figure. This dosage scale has proven optimal in our hands.

Complications

We have experienced no complications in this series of cases using this technique of preanesthetic medication. The premedicating dose of sodium pentobarbital is easily given at the designated time by the floor nurse who intermittently observes the patient during the preoperative hour.

Postoperatively, these patients are all returned to bed in a lateral semiprone position as a precaution against aspiration in case of emesis. Only about 10 percent of the patients had any nausea in their recovery period, and only one third of these any actual emesis. These children usually reacted by turning in bed and responding to mildly painful stimuli within the first 30 minutes, and then drifted off into a quiet sleep for several hours.

Nurses observing these patients postoperatively must be taught to recognize the difference between emergence from the anesthetized state, during which the patients must be closely observed, and the quiet sleep of a patient under the residual influence of his barbiturate premedication, when only intermittent observation is necessary.

Conclusions

We have presented a technique of preanesthetic medication in the ocular surgery of children that most consistently meets the several requirements necessary in carrying out a satisfactory anesthetic procedure for this special type of surgery. Sodium pentobarbital (Nembutal—Abbott) is a safe and adaptable preparation for preoperative medication in children between the ages of 15 months and four years, and a procedure and dosage have been recommended. In our experience with 128 cases, we have had no undesirable results and recommend the method as a clinical procedure of choice in these children.

247 East State Street (15).

SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

SWISS OPHTHALMOLOGICAL SOCIETY

September 26-28, 1952

RETROBULBAR PAIN WITH CEREBRAL TUMOR

DR. E. B. STREIFF AND DR. J. D. BUFFAT (Lausanne) presented the case history of a man, aged 37 years, who experienced intolerable pain behind the right eye with radiation to the neck in September, 1951. Arteriography suggested an aneurysm of the right internal carotid artery at the junction of the posterior communicating artery. Ligature of the right common and internal carotids caused the pain to disappear for 10 days, but it then recurred in full force.

In December, 1951, bilateral choked discs were noted. Left hemiparesis and ventriculography indicated a right-sided cerebral tumor. At operation, a glioblastoma in the right upper temporal lobe was removed. The visual acuity, which had fallen to 0.6, recovered temporarily to 0.9 after a series of retrobulbar injections of Roniacol. In a few months all previous symptoms recurred plus mental confusion. Death in coma ensued.

ALTITUDINAL HEMIANOPIA

DR. F. VERREY (Zurich) gave the following report:

A patient, involved in a motorcycle accident, became afflicted successively with acute severe anemia from internal hemorrhage, bronchopneumonia, and—a week after admission—visual obscuration associated with retinal hemorrhages, papilledema, a left central scotoma, and bilateral inferior hemianopia.

After two months the left disc was atrophic and the right disc hemiatrophic. Apparently an anemic atrophy sequential to internal hemorrhage occurred to which was added a retrobulbar neuritis by the bronchopneumonia.

PARINAUD'S SYNDROME

DR. H. R. BÖHRINGER AND DR. F. KOENIG (Zurich) analyzed 15 cases in which paralysis of upward gaze had been observed. Of these, 10 were due to pineal tumors and one each to poliomyelitis, trauma, vascular lesion, multiple sclerosis, and a granuloma, probably tuberculous. Paralysis of convergence was noted in two cases, reflex iridoplegia in 10.

MIGRAINE

DR. F. KOENIG (Zurich) studied two cases of migraine by electro-encephalography, and both demonstrated a vascular disturbance in the region of the occipital lobe.

INTERNAL FRONTAL HYPEROSTOSIS

DR. M. GRUBER (Zurich) mentioned that internal frontal hyperostosis is frequently noted by roentgenologists and is usually asymptomatic. In four patients, however, the following ocular disturbances were noted: retrobulbar pain; sensitivity of the globe and of the trigeminal nerve to pressure; scintillations; diminution of acuity, convergence, and accommodation; congested retinal veins and temporal pallor of the disc.

OCULAR PARALYSES IN CEPHALIC TETANUS

DR. H. WETTLER (Zurich) told of a man, aged 52 years, in whom a sliver of wood had penetrated the left orbit. Paralyses of the eye muscles and the left facial nerve were evident on the seventh day, trismus on the 10th day, generalized tetanus with opisthotonus on the 12th day, and death came on the 15th day. The cranial nerves, III to IX, had been affected. Bacteriologic examination disclosed Clostridium perfringens, Vibrio septicus, and Staph. aureus.

Experimental exophthalmos

Dr. J. F. Cuendet and Dr. S. Cruchard (Lausanne) found that exophthalmos produced in the guinea pig by injections of an extract from the anterior lobe of the pituitary could be controlled by Phenergan, which suggests that in such exophthalmos the pathogenesis is a disturbance of capillary permeability.

Familial corneal degeneration

Dr. M. Gruber (Zurich) noted that varying aspects of corneal degeneration may be seen in the same generation. In the family observed by him at least two "varieties" were present.

Retrolental fibroplasia

Dr. L. Hoffman-Egg, Dr. F. Verrey, and Dr. A. Tosello (Zurich) remarked that authentic cases of retrolental fibroplasia are rare in Europe and have been seen only in the large cities.

Diagnostic puncture

Dr. R. Brückner (Basle) stated that the one case in which he made a cell study from a diagnostic puncture of a ciliary melanoma confirmed the value of this procedure which was originally proposed by Quensell and Karp in 1928 and 1932.

Local use of PAS

Dr. R. Brückner (Basle) claimed that para-amino-salicylic acid is an effective remedy in scrofulous eye disease, used either as a powder or in a 20-percent ointment.

Rimifon in experimental ocular tuberculosis

Dr. R. Brückner (Basle) inoculated the anterior chamber of eight rabbits with bovine tubercle bacilli. Of six treated with Rimifon, four died from a Herxheimer reaction but the other two, with tuberculous conjunctivitis and iritis, respectively, became clinically cured.

Illness in amblyopic eyes

Dr. A. Bourquin (Lausanne) discovered essential amblyopia in 457 of 34,000 eye patients, equally distributed between the right and left eye. Excluding the cases of high anisometropic myopia, illness was found to affect the nonamblyopic eye as often as the amblyopic one.

Epithelioma of lids

Dr. E. Rosselet (Lausanne) generally prefers contact radiation to surgery in the therapy of epithelioma of the lids because the action is localized, superficial, and gives a better cosmetic result. However, recurrences are admittedly more frequent than with surgery. Contact radiation is indicated especially for lesions at the internal angle of the eye in the neighborhood of the lacrimal apparatus.

Tuohy contact lens

Dr. O. Knüsel (Aarau) gave a film presentation of a patient fitted with the corneal contact lens of Tuohy. The lens could be retained for 12 to 14 consecutive hours without showing any disturbance to the corneal epithelium when tested with fluorescein.

Simplified apparatus for orthoptics

Dr. H. Smolik (Montreux) presented a projection instrument that permits exercise at both distance and near. The observer, looking through red-green glasses, views on the screen red and green images reflected by two mobile mirrors. The apparatus can also be utilized for campimetry and for testing ocular motility.

A tropometer

Dr. W. Weidmann (Aarau) showed an original tropometer. The observer, who is seated at a two-meter distance and wears red-green glasses, directs a red spotlight to each of the nine green luminous points of the instrument in succession. The results are registered conveniently on the glass screen that constitutes the back of the apparatus.

John D. Blum (Geneva),
Correspondent.
James E. Lebensohn,
Translator.

YALE UNIVERSITY CLINICAL CONFERENCE

December 12, 1952

DR. R. M. FASANELLA, *presiding*

COMPLICATIONS OF CATARACT SURGERY

DR. ARTHUR M. YUDKIN said that it is essential that the person be examined thoroughly before being admitted to the hospital for intraocular surgery. A study of his habits are important to estimate the amount of medication necessary to allay the fears and apprehensions so frequent in persons who require cataract surgery.

With the advent of better local anesthesia and control of the ocular movement, less difficulty should be encountered in placing silk sutures in the ocular tissue. Many surgeons make the corneal incision with a keratome and enlarge the section with scissors. The use of the von Graefe cataract knife for complete corneal section is a lost art in this country.

No matter how the corneal section is made the incision should be confined to the area known as the external scleral sulcus. In this area the clear cornea and the vascular episcleral tissue are avoided.

When bleeding is encountered, it should be checked and, if the chamber is filled with blood, it is well to irrigate the blood before it coagulates on the iris or lens capsule.

Most surgeons agree that the intracapsular operation is by far the best method for removing the entire lens from the eye. Not all surgeons can perform this operation without real injury to the eye. There are some forms of cataracts that should be removed by the extracapsular method.

No matter how experienced the surgeon may be, complications frequently arise that tax his skill and ingenuity. The surgeon should be well versed in all these complications so when the emergency arises he can cope with the situation. The incision should be large enough to permit the extraction of the lens through the section.

In spite of every precaution, shelving of the cornea may take place when the original section is made with a keratome. Do not hurry the enlargement of the incision with scissors, be sure that the blades are in proper position before cutting.

If the pupil is not wide enough for the lens to be grasped with a forceps, sharp or blunt, or a suction apparatus, iridectomy should be made. If the pupil has been retained, it is important to make an iridotomy or peripheral iridectomy after the lens has been extracted.

Innumerable methods of suturing the cataract incision will be found in the literature. The sutures should hold the wound tight and allow proper healing of the anterior and posterior part of the incision. I have observed that deep sutures are difficult to insert even with good corneal needles and special forceps.

If a prolapse of the iris is imminent, examine the eye with a view of relieving any pressure on the eyeball from within or without the globe. A prolapse of iris occurs more often after a simple extraction in which the peripheral iridectomy is omitted and the coaptation of the wound is not secured properly with sutures.

Refrain from cauterization of the iris prolapse by cautery or chemicals.

Most eye surgeons agree that the vitreous may be lost in any type of cataract extraction. Severe loss of vitreous is rare, owing no doubt to present-day methods of anesthesia, sedation, and improved operative technique. I agree with most operators, that a loss of vitreous is a complication never to be minimized and always to be regarded with apprehension.

It is well known that surgery on the anterior segment of the eye carries with it the danger of introducing into the eye infection, foreign materials such as cilia, pieces of rubber from irrigators, talcum from rubber gloves, and fibers from cotton sponges and linen used in draping the patient. In spite of every effort to prevent exogenous infection, this disaster occurs particularly in the feeble and in diabetics. In some cases when it

appears after the fifth day, it may be considered as endogenous.

Some surgeons advocate a small conjunctival flap to prevent bleeding into the chamber and the formation of epithelial downgrowths into the wound. The wound should be freed of vitreous, lens capsule, iris prolapse, and strands of epithelium to avoid delayed reformation of the anterior chamber. Secondary glaucoma may be a sequel to this complication.

Hyphema may occur in about the same proportions in both types of operation (round pupil and iridectomy).

About 25 percent of all hemorrhages in the anterior chamber are attributed to injury yet no history of local injury was obtained. In my experience, hemorrhages in the anterior chamber are rarely traumatic in origin. I believe that the bleeding comes from broken limbal vessels produced by separation of the wound.

It is generally recognized that the presence of broken-down lens tissue in the eye may result in various types and grades of inflammation. Retained fragments of lens cortex may produce a severe iritis or iridocyclitis. This condition has been attributed to an allergic reaction of the eye to the lens tissue.

Recent reports of eyes received in some of the pathology laboratories show that the anterior segments have definite pathologic changes but that the posterior portions are relatively normal. It has been interpreted that these eyes might have been saved if the lens substance had been removed. Th inflammation was considered as a potential sympathetic ophthalmia and the eye was removed.

The main principles of cataract surgery are to extract the lens as completely as possible with the minimal amount of injury to the eye; the incision should be free of vitreous, strands of lens capsule, bulbar conjunctiva, and prolapsed iris; the sutures should hold the approximated surfaces of the incision so as to seal the anterior chamber. The surgeon should not attempt intracapsular surgery until he has become proficient in extracapsular procedures.

Discussion. Dr. Rosenthal reviewed two of his cases of extracapsular cataract extraction with considerable retained lens material in which topical cortisone was used, starting on the sixth day. The lens material absorbed almost completely, and Dr. Rosenthal believed that this occurred because the cortisone prevented the inflammatory reaction in the anterior chamber.

Dr. Glass confirmed Dr. Rosenthal's observation with a case of his own in which complete clearing occurred with cortisone topically, despite an anterior chamber hemorrhage on the fifth day following extracapsular extraction. He stated that similar findings had been mentioned to him by several other ophthalmologists who also used topical cortisone postoperatively.

Dr. Blake mentioned a vertical iridotomy including the pupillary margin as a useful compromise between complete iridectomy and a small peripheral iridotomy. This also allows easier extraction of the lens and gives almost as good a cosmetic result as the round pupil operation.

Dr. Kaplan: What is the real advantage of the round pupil operation?

Dr. Yudkin: Besides the cosmetic advantage, less photophobia results.

Dr. Ryder described a case of intraocular infection, due to infected teeth, which occurred four months postoperatively. He emphasized preoperative dental prophylaxis and antibiotics.

Dr. Wong: What are the complications which might be particularly attributed to diabetes, and their management?

Dr. Yudkin: I give rutin and vitamin C preoperatively for two weeks, and find no higher incidence of cyclitic reactions than in the nondiabetic.

Dr. Kaplan described a case of postoperative B. coli infection, with ultimate loss of the eye.

Dr. Yudkin discussed the additional hazards of infection associated with lint in the operating room, particles from rubber ir-

rigating bulbs, fragments from broken glass suture tubes, and so forth.

In closing, Dr. Yudkin stated his belief that many postoperative glaucomas must have really been early glaucoma before operation. He stated that atropine, postoperatively, should not usually be necessary for more than a few weeks, but that it could safely be used for a month or more.

Cataract case with complications

Dr. Andrew Wong (resident) presented the case of R. B., a 66-year-old white woman, a widow, with known hypertensive and arteriosclerotic heart disease who was admitted to the New Haven Hospital over a year ago for cataract extraction in the right eye.

Present illness. Sixteen years ago, the patient noted blurring of vision, O.D. Fundus study revealed hazy media, vitreous floaters, arteriosclerotic retinopathy, and incipient lens changes. Visual acuity was 20/200, O.D., and 20/25, O.S. Seven years ago, no definite lesions were seen in the right retina but numerous white exudates in a large arc around the macula with star-shaped figures near the center were described.

Cataract workup showed tension: 16 mm. Hg (Schiøtz), O.U.; light projection good, O.U.; two-point light discrimination at eight cm., O.S.; 15 cm., O.D. The pupils dilated poorly; slitlamp examination showed no flare or keratic precipitates. Both lenses showed diffuse dense nuclear cataracts, the right being more opaque than the left. Vision was: Hand motion, O.D.; finger counting at one foot, O.S.

Past history. Twenty-two years ago the patient had a basal-cell carcinoma on her right lower lid which was successfully treated with radium.

Operation. At operation, a conjunctival flap was made and a keratome incision placed at the 12-o'clock position was enlarged nasally and temporally with a spring corneal scissors. Three corneoscleral sutures were postset and two peripheral iridotomies were performed at the 11- and 1-o'clock positions.

A Harrington erisophake was used to deliver the lens. Due to the constricted pupillary aperture, the delivery of the lens was arrested and the capsule was ruptured inadvertently and delivered extracapsularly without complication.

The corneoscleral sutures were drawn tight and the anterior chamber irrigated with saline. The iris was reposited and the conjunctival sutures closed with interrupted silk sutures. A bubble of air was used to reform the anterior chamber.

Postoperative course. On the sixth day after operation, the anterior chamber collapsed and iris incarceration from the 10:30- to 1:30-o'clock positions was seen. This was accompanied by acute head pain, chemosis of lids, edematous conjunctiva, and a slight central hyphema. There was a small amount of cortical material behind the pupil. In the ensuing 10 days, the chamber slowly reformed. The sutures were removed after three weeks and the patient was discharged on atropine and local cortisone.

The medications were neglected in a nursing home and appointments were not kept. Three weeks after discharge the patient was seen in Eye Clinic. A dense secondary pupillary membrane was present with posterior synechias, scattered iris pigment, and old keratic precipitates. There was no flare. Tension was slightly elevated, O.D. Light projection was good.

Nine months after the operation, with the eye quiet and normal tension, the patient consented to a punch excision of the membrane and drawn iris, which was done. During the postoperative course, there was much anterior-chamber hemorrhage. On discharge, there was no light perception and the pupil was black with no light reflex on examination with the ophthalmoscope. Two months later, light perception could be seen temporally only and the eye had not developed any new activity.

William I. Glass,
Secretary.

AMERICAN JOURNAL OF OPHTHALMOLOGY

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THE 1953 ACADEMY MEETING

The American Academy of Ophthalmology and Otolaryngology, probably the largest specialty society in the world and certainly one of the most important, held its 58th annual session at the Palmer House in Chicago on October 11th to 16th. Noted for the excellence of its scientific program there was this year an unusual abundance of papers of very high caliber. Of particular importance were papers by Dr. Arnold Patz, of Baltimore, and Dr. Norman H. Ashton of London, on the experimental production of retrolental fibroplasia in the eyes of animals. Both investigators independently reported the development of lesions resembling human retrolental fibroplasia in the eyes of numerous young animals exposed to high concentrations of oxygen. Dr. Alan C. Woods and his collaborators pursued the suggestion of Mrs. Wilder last year in her report on the finding of a toxoplasma-like organism in acquired uveitis in the adult and investigated cases of uveitis with the

conclusion that toxoplasmosis might well be one of the causes of this condition. Mrs. Wilder and her group reported on the serologic tests in those cases in which the organisms had been histologically observed.

Always calculated to be a subject to draw a capacity audience, "Cataract extraction" was selected as the subject of this year's symposium in which Drs. Kirby, Atkinson, Davis, Fry, Vail (in absentia), McLean, Clark, Chandler, and Guyton participated.

As was to be expected the field was covered in a most thorough manner. On the final day a follow-up report on the Ridley operation was presented by Dr. Warren Reese, Dr. Hunter Romaine, and Dr. John Finlay, and discussed by Dr. Fry as a representative of the cataract panel. While the first essayist expressed some enthusiasm for the operation, the consensus was that that procedure was still in an experimental stage and that visual results were not as yet on a par with standard methods of extraction.

Following the practice of recent years, each morning session devoted to scientific papers on ophthalmology was opened with a clinicopathologic case report. Among the papers presented were the following: "Contact lenses," by Dr. J. L. McGraw; "Differentiation and treatment of eczemas of the eyelids" by Dr. F. H. Theodore; "Antihyaluronidase and antistreptolysin titers in uveitis" by Dr. I. H. Leopold and Dr. T. G. Dickinson; "Roentgen diagnosis of lacrimal gland tumors" by Dr. R. L. Pfeiffer and Dr. I. S. Jones; "Lacrimal gland tumors" by Dr. A. W. Forrest; "Role of vitreous detachment in aphakic and malignant glaucoma," by Dr. R. N. Shaffer; "A study of primary and auxiliary medical ocular rotation," presenting evidence of the role of the vertical recti in medial rotation, by Dr. Orville Gordon; "Sterilization of sharp instruments by boiling with utilization of cathodic protection to prevent corrosion," by Dr. W. H. Havener and Dr. C. A. Siebert, and "Squint operations and binocular function" by Mr. Frank Law of London. Excellent moving pictures were presented on "A simplified dacryocystorhinostomy" by Dr. Charles Iliff; "Lamellar sclerectomy in retinal detachment" by Dr. Olga Ferrer; and "Reconstruction of the lacrimal passageway after disease of the lower canaliculus" (with music) by Dr. Alston Callahan.

The Jackson Lecture, sponsored by the Ophthalmic Publishing Company, was presented by Dr. Harold Falls of Ann Arbor and proved to be one of the highlights of the meeting. His subject was "Clinical detection of the carrier state in ophthalmologic pathology." At the opening session, Dr. Frederick C. Cordes in his presidential address discussed the American Board of Ophthalmology and emphasized the fact that the certificate of the board implies only that the holder possesses minimal qualifications and does not imply that he is a qualified consultant or ophthalmic surgeon. Dr. Lawrence T. Post, the guest-of-honor, was prevented from attending due to poor health but his paper was read by his brother, Dr. M. H. Post. This was a discussion on the "Art of medicine" as applied to ophthalmology with much excellent philosophic and practical consideration of the subject. Mr. Frank Law of London, the guest speaker (later made an honorary member of the Academy), spoke on the "Changing face of medicine," which proved to be a most illuminating description of the British socialized medicine program.

A pioneer in the "instructional hour" program of postgraduate medical education, the Academy this year sponsored 117 individual and 45 continuous courses *in ophthalmology alone*, with 204 instructors participating in 414 hours of instruction. Further variety in fare was offered by meetings on industrial ophthalmology, orthoptics, allergy, and plastic surgery held by various committees and organizations in conjunction with the Academy. The usual alumni dinners, evening of diversion, and annual banquet provided the lighter side between the strenuous scientific programs.

Scientific and technical exhibits were excellent and well attended. Mrs. Wilder and Major Bickerton's exhibit on organisms in inflammatory diseases of the eyes received the first award; Drs. Forrest, Jones, and Pfeiffer's exhibit on tumors of the lacrimal gland received second place; and Dr. Fink's exhibit on vertical oculomotor problems received third-place award.

It is of interest that previous registration records were broken, with a total of 5,549 individuals registered, including 2,351 fellows, 1,164 professional guests, 204 candidates, 116 orthoptic technicians, 588 technical exhibitors, and 1,126 ladies.

At the business meeting the following officers were elected for the coming year: President, Dr. Walter Theobald; president-elect, Dr. Algernon B. Reese; first vice-president, Dr. Francis H. Adler; second vice-president, Dr. Theodore Walsh; third vice-president, Dr. Dohrmann K. Pischel; councilor, Dr. Samuel E. Roberts; executive secretary-treasurer, Dr. William L. Benedict; secretary for ophthalmology, Dr. Kenneth Roper; secretary for otolaryngology, Dr. L. Boies; secretary for instruction in ophthalmology, Dr. A. B. Ruedemann; secretary for instruction in maxillofacial surgery, Dr. Dean Lierle; secretary for home study courses, Dr. Daniel Snydacker; secretary for public relations, Dr. Erling Hansen.

William A. Mann.

XVII INTERNATIONAL CONGRESS OF OPHTHALMOLOGY

The International Council of Ophthalmology has extended the scope of the XVII International Congress of Ophthalmology scheduled to be held in New York in September, 1954. In addition to the program already arranged for the New York meeting there will be a two-day session in Montreal, Canada, on Friday and Saturday, September 10 and 11, 1954. The congress will reconvene in New York on Monday, September 13th, and continue through Friday, September 17th. The registration fee will cover both the Montreal and the New York sessions.

Advance registration and the administrative affairs of the congress will be handled through the office of the secretary-general, Dr. William L. Benedict, 100 First Avenue Building, Rochester, Minnesota.

OBITUARY

BROWN PUSEY, M.D.
1869-1953

Dr. Brown Pusey died at St. Luke's Hospital, Chicago, July 4, 1953. He represented the last of the older group of famous Chicago ophthalmologists. One of the earliest supporters of the JOURNAL, he was closely associated with the progress of his specialty.

Dr. Pusey was born in Elizabethtown, Kentucky, on April 14, 1869. He was the son of Dr. Robert Pusey, a pioneer in Kentucky medicine. In his home town there exists a memorial to the Pusey family, to the father Robert Pusey and the sons, Brown Pusey and William A. Pusey, a noted Chicago dermatologist.

In 1889, Dr. Pusey was graduated from Vanderbilt University and took his M.D. degree at the University of Pennsylvania in 1892.

He did postgraduate work in Germany and Vienna in 1898 and again in 1904. In the Navy he served as assistant surgeon from 1893 to 1896. In 1896 and 1897 he occupied the post of house surgeon at the New York Eye and Ear Infirmary.

Dr. Pusey's Chicago practice began in association with the late Cassius Westcott in 1899. He was instructor in pathology at the University of Chicago from 1902 to 1908. From 1908 to 1927 he was professor and head of the Department of Ophthalmology, Northwestern University Medical School, and later he was made professor emeritus.

He was a member of the American Oph-

thalmological Society, American Medical Association, Illinois Medical Society, Chicago Medical Society, and the Chicago Ophthalmological Society. He was a fellow of the Institute of Medicine from 1915 to 1938 and emeritus fellow, 1939 to 1944, and benefactor in 1945.

In recent years, since his retirement, he made his home at the University Club, spending the winter months at Chandler, Arizona. Until recently he spent his summers at the Glen View Golf Club.

Frank E. Brawley.

CORRESPONDENCE

On Benevenutus Grassus

Editor,
American Journal of Ophthalmology:

In your interesting corner "Ophthalmic Miniatures" in the April, 1953, issue (vol. 36, p. 466) of The Journal, there appeared a note taken from the praise-worthy translation by Casey A. Wood of the *Practica oculorum* of Benevenutus Grassus of Jerusalem. It refers to an antiquated prescription of an ointment for eye diseases.

From a more intimate study of this very valuable medieval Latin document of ophthalmic practice, which from the beginning of the 12th century well into the end of the 16th century was the most authoritative textbook on the subject, I firmly believe that the prescription in question cannot possibly be ascribed to Benevenutus Grassus (or Grapheus) of Jerusalem.

For this statement, intended also to vindicate the 12th century author's honor, there are two good reasons. First of all, the note taken from the Ferrara incunabulum (published in 1474) is printed there on the last page under the word FINIS. This, therefore, clearly is an addition, made by a more or less "learned" copyist, which the printer has found in the manuscript before him and obediently set up. By comparison with some of the other codices of the same work in the text itself of the Ferrara publication there can be detected a goodly number of other later insertions and changes. This used to happen to many manuscripts of old when it pleased the taste or the bias of the copyist—just as it happened in this case. And it should be remembered that over two centuries lie between the composition of the work and its first printing.

The second, still weightier reason why it could not possibly be one of Benevenutus' original prescriptions is the following: His reasoning, within the frame of medieval scholasticism of course, is always rational. Nowhere among his numerous recipes (which seem to have been efficacious to some extent), strange as they may look to a modern medical man, can there be found a shadow of superstitious belief such as—to our amusement—is apparent in the short precription quoted, where *"urina pueri virginis"* is mentioned twice.

(Signed) Aryeh Feigenbaum,
Jerusalem.

Sympathetic ophthalmia following cyclodiathermy

Editor,
American Journal of Ophthalmology:

In the February, 1953, issue of The American Journal of Ophthalmology was published my paper, "Sympathetic ophthalmia following cyclodiathermy." In this article, I stated that, although four cases of sympathetic ophthalmia following cyclodiathermy had been mentioned in the literature, no case reports had been presented in detail.

Among the cases quoted was one reported by Dr. Charles Thomas of Nancy, France. In the article from which I culled this case (Bull. Soc. d'opht., Paris, April, 1948, p. 205) he presented the complications following 100 cases of cyclodiathermy. No case details were given.

On May 30, 1953, Dr. Thomas wrote me to correct an oversight on my part. With his letter he sent a copy of the article in which he presented the case alluded to in the

above article. Entitled "Un cas d'ophtalmie sympathique après cyclodiathermie perforante," his presentation appeared in the *Bulletin de Société d'ophthalmologie de France,* 1947 (Nov. and Dec.) p. 605. In this article he presents the case of a 59-year-old woman who suffered a nonperforating blow to one eye which resulted in subluxation of the lens, a large hyphema, and secondary glaucoma. The latter was treated by perforating cyclodiathermy. Three and a half months later, the opposite eye developed sympathetic ophthalmia. This was proven by subsequent pathologic examination of the enucleated injured (exciting) eye. Thomas concluded his report by offering the suggestion that if the diathermy current were maintained for a longer period of time (10 seconds) the points of entry for sympathetic ophthalmia could be eliminated.

I trust that the above information will correct an erroneous impression which my article on sympathetic ophthalmia may have caused. It is also interesting to note that Thomas remarks on the rarity of reports on sympathetic ophthalmia following cyclodiathermy.

(Signed) Martin Bodian,
Brooklyn, New York.

Ready-made drug mixtures

Editor,
American Journal of Ophthalmology:

Cortomyd is the latest, but probably not the last, of products adding cortisone to local ophthalmic therapeutics. It contains sodium sulfacetimide and cortisone; others combine cortisone with neomycin or bacitracin. Questions arise as to the wisdom of this new trend.

Cortisone can be life saving for an eye. So can the antibiotics or sulfonamides. The reasoning that, if one is good for the eye and the other is also good for the eye, then both together must be even better for the eye, seems crude. Atropine is also good for the eye. Let's add some atropine. And then, of course there's vitamin A. . . .

The constituents of these new preparations are not indifferent drugs but potent weapons which may have undesirable side effects. Cortisone is able to release the dormant intracellular herpes virus in the cornea and provoke herpetic keratitis. It seems for this reason to be contraindicated in dendritic and disciform keratitis. Cortisone has also been reported several times to have provoked glaucoma, probably in predisposed eyes. The general practitioner, to whom the new combinations may appeal particularly, is not in a position to diagnose or prevent trouble of this kind when it occurs.

The ophthalmologist wants to have a free hand in treating cases with the antibiotic or sulfa drug of his choice, and to regulate the dosage of cortisone; he cannot do this if he uses ready-made mixtures of both. What is more, very few conditions actually need local antibiotic and sulfa therapy at the same time as cortisone. External infections which benefit from local therapy respond as a rule very satisfactorily to the antibiotics. Cortisone is not needed for them. Conditions in which cortisone is effective, like uveitis, do not respond to local antibiotic or sulfa therapy. This narrows the indication of the new combinations down to a very few diseases. But the general practitioner, who cannot be aware of the details of ophthalmic therapy, will be sorely tempted to use the combination of two miracle drugs in all the "sore eyes" in his waiting room. This is shotgun therapy which may have dire consequences.

We are grateful for the wisdom and thought which the pharmaceutical industries have applied to the research preceding and accompanying the creation of the great new therapeutic agents. We should object to indiscriminate exploitation with eye-catching ill-considered mixtures.

(Signed) John J. Stern,
Utica, New York.

BOOK REVIEWS

OCULAR THERAPEUTICS. By William J. Harrison, M.D., Phar.D. Springfield, Illinois, Charles C Thomas, 1953, edition 2. 282 pages. Price: $6.50.

This pocket-size monograph is a guide to ocular therapeutics and is written particularly for the young ophthalmologist. It is limited almost entirely to the official drugs found in *U.S.P. XIV*, *National Formulary IX*, and *New and Nonofficial Remedies*. Chapters on isotonic solutions, buffered solutions, anticoagulants, and the therapeutic hormones are important features.

As an aid in writing prescriptions with care in respect to incompatibilities of various ocular drugs and in respect to tonicity and buffering of the solutions intended for use in the eye, this book will be very valuable to the beginner in clinical ophthalmology.

John G. Bellows.

TREATMENT OF AMBLYOPIA (AMBLYOPIEBEHANDLUNG). By Alfred Bangerter, M.D. Basle, Switzerland, S. Karger, 1953. Paper covered, 95 pages. Price: 11 Swiss Francs.

This monograph is rather unique. It is the only publication known to me which devotes itself entirely to the treatment of amblyopia in all its manifestations. It is comprehensive and thorough. All methods and devices are carefully described and evaluated. A large number of relatively new procedures and instruments devised by the author are fully explained and illustrated. Since amblyopia is so often associated with strabismus, brief references to the latter condition and to orthoptics, about which the author promises to write fully in a later publication, are found here and there.

But the author makes a clear-cut separation of visual (acuity) training from orthoptic training. In fact, he has coined a new term for the former, "pleoptics," which by derivation means "more vision." Those with a reading knowledge of German will profit greatly from a perusal of this modest volume.

Joseph I. Pascal.

BULLETIN ET MEMOIRES DE LA SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE, Paris, Masson et Cie, 1952, vol. 65, p. 447.

This report of the annual meeting of the French Ophthalmological Society which was held in Paris from June 22 to 26, 1952, is the record of a multitude of interesting and timely papers.

L. Guillaumat and R. Robin report a study of the visual fields in cases of intracranial, nontraumatic lesions and evaluate the localizing importance of perimetry in connection with other clinical signs and symptoms. R. Hermans, an expert on illumination, believes that the flickering of the fluorescent light-tubes causes visual fatigue and suggests adequate changes in its installation. A. Franceschetti, S. Forni, and F. Kessel report on a case of chronic glaucoma in which careful field studies showed homonymous depression and led to the diagnosis and discovery of a pituitary tumor.

Ten papers devoted to neuro-ophthalmology were presented. A. Hoorens stressed the importance of the cervical sympathetic nerve fibers in pupillary movements and evaluated the action of miotics and mydriatics. G. Bonomont described the occurrence of Adie's symptom after chickenpox in a three-year-old boy. P. Marx noted unilateral paralysis of both the pupillary sphincter and the ciliary muscles after diphtheria. Druault-Toutesco considers the static anomalies of the pupils to be as valuable diagnostically as the pupillary reflexes. Calmettes, Deodati, and Amalric stressed the importance of arteriography in intracranial lesions and reported a case of pulsating exophthalmos caused by a dilated internal carotid and a bone defect from metastasis of a thyroid tumor.

The papers read on June 23rd dealt with diseases of the uvea and glaucoma.

H. Chardun and P. G. Moreau observed a diffuse fast-growing malignant melanoma of the iris. N. C. Trantas discussed varieties of cysts of the iris, the development of recurrent cysts, and described four cases. P. and J. Lavat offer an explanation of the negative serologic tests in three otherwise typical cases of toxoplasmosis. N. Sezer recalled the history of Behçet's disease and claimed to have isolated a specific virus which produces encephalitis in the mouse, a characteristic eye disease in the rabbit, specific antibodies in affected individuals, and which grows in a specific way on the chorioallantois of the egg.

J. François' paper on electroretinography in glaucoma is very impressive. In congestive glaucoma, the retinogram may be supernormal; in chronic glaucoma, it is normal except in far-advanced retinal degeneration when it is subnormal. In absolute glaucoma it is either subnormal or negative; in secondary glaucoma, the electroretinogram depends on the amount of retinal degeneration.

M. and I. Stankovitz consider photophobia to be an isolated early sign of congenital glaucoma. They believe it to be a pseudophotophobia originating in the hypothalamus.

The 12 papers read during the session of June 25th dealt with the retina and its diseases. P. Guillot and J. Bonnal discussed obstruction of the retinal artery and reviewed one of their cases in detail. They suggest that the patient lie down with the head lower than the body. If there should be an atony of the artery the bloodflow will be resumed. In an organic block the bloodflow will not improve.

Ardonin, R. Toulouse, and J. Dubois believe that the measurement of the pressure in the retinal artery after Bailliart might be an important diagnostic sign in toxemia of pregnancy. A change in the normal 1 to 2 relationship of the retinal and brachial diastolic pressure is the earliest sign of impending toxemia and after delivery it has prognostic value toward complete or incomplete recovery.

R. Onfray, M. Bonamy, and J. Bescol-Liversac tried to correlate fundus changes and hypertension with biopsy findings of the kidney and adrenals. L. Alearts saw several cases of flat intraretinal cysts and offers an explanation of their origin. V. Bischler reported a case of vitelliform cyst of the macula.

J. Beauvieux and P. Pesme gave an exact description of a case of pseudoglioma which proved to be a benign tumor of the choroid. A. Bronner and A. Lobstein call attention to the diagnostic value of retinal dynomometry in obstruction of the internal carotid and its branches. Deviations from the normal varied according to the level of the lesion and the presence or absence of superimposed spasm.

E. B. Streiff reported three cases of keratoconus and retinitis pigmentosa. He considers the possibility of a genetic linkage. J. Marwas read an unusually interesting paper on the sympathetic innervation of the retina.

Twelve papers on various subjects were presented on June 26th, the last day of the meeting. A. Fritz demonstrated an original method for treating false projection in strabismics. J. Malbran and G. Sevrin reported on two patients with supranuclear monocular paralysis of both elevators. They discussed the differential diagnosis and the successful surgical adjustment.

M. Dejean and Mlle. Guyon gave detailed information on a lymphosarcoma originating from the orbital floor in an eight-month-old child. Ch. Thomas observed a case of ocular lymphogranuloma, simulating the clinical picture of tularemia.

P. Jeandilze, Jean Sedan, and P. Bardelli believe that ascorbic acid and associated endocrine therapy check the progression of lens opacities in early senile cataracts. H. Arruga reported on the Ridley operation for cataracts which he had performed 13 times. The plastic lens fell into the vitreous twice. The iris reaction was very marked. J. Barraquer, in discussing Arruga's paper, said

that he injected cortisone into the anterior chamber at the end of the operation to avoid iris reaction. Alice R. Deutsch.

SURGERY OF THE EYE. By Meyer Wiener, M.D., and Harold G. Scheie, M.D. New York, Grune and Stratton, 1952, third edition. 449 pages. Price: $15.00.

Previous editions of this text on ocular surgery have proved extremely popular and this new, third edition, in which Dr. Scheie appears as co-author, undoubtedly will be well received. As in the past, only those procedures which the authors utilize and recommend are included and described. Several chapters have been completely rewritten and a number of new operations described in an effort, for the most part successful, to bring to the reader some of the most modern developments in the field.

The text is clearly and simply written and profusely illustrated with excellent drawings so that the book makes an excellent text for the beginner in eye surgery, as well as for the experienced surgeon. Certainly most of the standard operations are included and, while not every acceptable method is described, any surgeon who limits himself to the recommended techniques will find himself equipped with a fairly complete surgical armamentarium.

Among the more modern aspects of ocular surgery described are the use of ACTH and cortisone, antibiotics as prophylaxis against operative infection, and such operations as goniotomy and goniopuncture. The introductory chapter on the "Basic technics in ophthalmic surgery" is excellent for the neophyte. William A. Mann.

JOURNAL OF THE ALL-INDIA OPHTHALMOLOGICAL SOCIETY, volume 1, number 1, April, 1953. Editor, Dr. S. N. Cooper, Laud Mansion, 21, Queens Road, Bombay 4, India. Managing Editor, Dr. Y. K. C. Pandit, Bombay Mutual Buildings, Hornby Road, Bombay 1, India. Yearly subscription (four issues): Rs. 12/- Overseas, £1 or $3.50. Single copy: Rs. 4/-.

THE AMERICAN JOURNAL OF OPHTHALMOLOGY welcomes this newcomer to the field of current ophthalmic literature and wishes it the success that its first issue promises.

Consisting of 42 pages, this first number contains four well-written and well-illustrated articles, Indian ophthalmic news, and a 10-page section devoted to a review of the literature. Of particular interest is this section for in it the editors have departed from the abstract forms usually employed in medical journals and have devised a system of making each abstract a certain length and printing it in a uniform space (3 by 6 inches) so that each review can be clipped and filed for ready reference. In addition, the second page of the Review Section contains a number of one- or two-sentence therapeutic and clinical excerpts from the current literature.

On the editorial committee are Tulsi Das, S. N. Mitter, S. P. Gupta, Dukhan Ram, B. K. Das Gupta, Colonel Papatala, G. Zachariah, P. Ramchander, B. K. Narayan Rao, and Victor C. Rambo.

Katherine Chalkley.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

1

ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Bietti, G. **Effects of experimentally decreased or increased oxygen supply in some ophthalmic diseases.** A.M.A. Arch. Ophth. **49**:491-513, May, 1953.

The author reviews the effects of anoxia on the normal eye and presents the results of a study of the effects of anoxia on abnormal eyes. Patients with a wide variety of diseases were studied: lesions of the optic nerve and pathways, inflammatory and degenerative lesions of the choroid and retina, and anomalies of ocular motility. In general, the production of anoxia increased visual field defects caused by a variety of lesions. Thus, in early cases, the production of a temporary anoxic state may lead to earlier diagnosis by enhancing demonstrable visual field defects.

G. S. Tyner.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Brand, I., and Takats, I. **Biologic examination of a new synthetic mydriatic.** Klin. Monatsbl. f. Augenh. **122**:576-584, 1953.

Labotropin is a new synthetic drug with parasympatholytic effect. It dilates the pupil better than homatropin, but the effect is less lasting. The intraocular pressure is not influenced. Biologic evaluation of the drug on the heart of the frog and on the isolated gut of the cat proved it to be a stronger antagonist to acetylcholin than homatropin. (14 figures, 4 references) Frederick C. Blodi.

Capalbi, S. **The in vitro activity of terramycin and chloramphenicol in association with commonly used local therapeutic agents. (In vitro studies on cultures of staphylococcus aureus and B. coli)** Arch. di ottal. **57**:85-94, March-April, 1953.

Both terramycin and chloramphenicol may be combined with the more common topical eye drugs such as atropine, pilocarpine, scopolamine and cocaine, without reduction of their therapeutic activity. A certain synergism exists between terramycin and penicillin or streptomycin, less pronounced when neomycin is combined with terramycin, absent in the combination of terramycin with aureomycin or chloramphenicol. The antibiotic activity of chloramphenicol is not modified by the combination with terramycin, penicillin

or neomycin. The combination of chloramphenicol with streptomycin resulted in an inhibitory activity similar to that of streptomycin alone. John J. Stern.

Dorello, U., and D'Amelio, V. **The antibacterial activity in vitro of neutral sulfate of atropine.** Arch. di ottal. **57**:119-127, March-April, 1953.

The addition of 1-percent atropine sulfate to cultures of 63 different species of microbes showed that atropine had a clear bacteriostatic and occasionally even bacteriocidal activity on most of them.
John J. Stern.

Marsico, V. **The role of vitamin E in the modification of the glucose content of the aqueous.** Arch. di ottal. **57**:111-118, March-April, 1953.

Vitamin E caused a fall of the glucose content of the blood and aqueous in rabbits made diebetic with alloxane. This points either to a regulative hormonal activity or a raising of the blood-aqueous barrier. John J. Stern.

Schwab, F., Wyt, L., and Binder, R. **The effect of ultrasound on corneal nerves.** Klin. Monatsbl. f. Augenh. **122**: 693-704, 1953.

Ultrasound often has a good effect on neuritis and neuralgia. To explain this, the effect of ultrasound was studied in animal experiments on corneal nerves. In one series the rabbits received 1 Watt per cm^2, which is comparable to a therapeutic dose. The histologic changes of the corneal nerves (granulation and fragmentation) were temporary, and disappeared after 12 hours. The sensitivity of the cornea was decreased for at least four hours. The second series was treated with the unusually high dose of 4 Watt per cm^2. The corneal nerves showed immediate severe damage and disappeared entirely after one week. (6 figures, 15 references) Frederick C. Blodi.

Ullerich, K., and Durchschlag, G. **Experimental examinations of the influence of drugs on the regeneration of corneal epithelium.** Klin. Monatsbl. f. Augenh. **122**:705-718, 1953.

The authors tried to produce a standard erosion of the cornea in rabbits by using the steam of Wessely's thermocauter. One percent cortisone, desoxycorticosterone and 1 per cent Doryl did not influence the rate of regeneration. (8 figures, 48 references) F. Blodi.

4
PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Allen, M. J. **An investigation of the time characteristics of accommodation and convergence of the eyes.** Am. J. Optometry **30**:393-402, Aug., 1953.

Experiments on six subjects are reported, giving measured time intervals for changes of accommodation in one eye with simultaneous measurement of convergence. The instrument used was a haploscope in which a binocular concentric ring target could be made to change distance instantly. The resulting change in accommodation of one eye was estimated by the simultaneous apparent position of a vernier grid pattern of a modified Fry optometer. Attention was maintained on the ring target, while in a fifth of a second the grid was estimated. At the same time changes in convergence were measured by photography with an A.O. Ophthalmograph. Convergence began sooner and increased faster than did accommodation. Reaction time is estimated as 0.2 second for convergence, and 0.3 second for accommodation for the subjects tested. For the two diopters maximum accommodation stimulated, convergence reported varied between 0.8 and 25 degrees, with an unexplained individual variation. It is reasonable to suppose that ciliary muscle action would be slower

than internal rectus action from the same stimulus. Paul W. Miles.

DaSilva, A. G. **Physiological tremor of the eyes. Nystagmus. Possible explanation of twinkling of the stars.** Arq. brasil. oftal. **15**:63-68, 1952.

While studying microphotography of the eye, the phenomenon of double images was observed, and was interpreted as evidence of slight motion of the eye. This was considered an error in technique, but variations of the photographic routine did not eliminate the double images. It was determined by measurement of the separation of the images and photography at varying times of exposure, that the eye oscillates normally each one-half second approximately 0.2 mm. Further investigation indicated that the oscillation was essentially rotary in nature, about ten to twenty degrees from the perpendicular. These excursions are minimal, physiologic, synchronous, and symmetrical in each eye, although each eye rotates in a direction opposite to its fellow, that is, when the right rotates clockwise, the left rotates counterclockwise.

Theories as to the mechanism involved in this oscillation are clonic contraction of the extra-ocular muscles, pulsations from the central retinal artery or ophthalmic artery, and the involuntary minimal movements of fixation (Helmholtz). The author believes the clonic contractions to be the cause of the oscillation. He has demonstrated similar movements in a patient with nystagmus, although the amplitude of the movement was greater. He believes that this phenomenon partially explains the well known "twinkling" of the stars. If one compares laboratory investigations in which point sources of light stimulate rods and then both rods and cones, and observations in astronomy, the sensation of "twinkling" seems to be due to alternate stimulation of rods, and of rods and cones simultaneously. The physiologic tremor of the eye tends to neutralize the different images formed by this retinal stimulation. James W. Brennan.

Keeney, A. H., and Duerson, H. L., Jr. **Evaluation of plastic spectacle lenses.** A.M.A. Arch. Ophth. **49**:530-535, May, 1953.

Using standard procedures, the authors made comparative tests on commercial glass and plastic spectacle lenses. Two plastic lenses, "Armolite," in prescription strengths, and "Plastolite," in plano, proved superior to case-hardened glass in resisting high velocity particles and welders' splatter. Both of these plastic lenses proved resistant to common household chemicals and high temperatures.
G. S. Tyner.

Schapero, M., and Levy, M. **The variation of proximal convergence with change in distance.** Am. J. Optometry **30**:403-416, Aug., 1953.

Convergence in near vision is the result of three distinct factors: accommodation, proximal convergence (from a sense of nearness), and fusional convergence. Tait has defined proximal convergence as that difference in measured phoria at 6 meters from that measured at 33 centimeters through +3.00 diopter lenses. Under these conditions, fusion is eliminated, and accommodation is unnecessary, so only proximal convergence remains. By use of appropriate lenses for the various distances, proximal convergence was measured at different distances from the eyes of eight subjects. While there was considerable individual variation, there was a tendency for the rate of increase of proximal convergence to increase in near vision. Paul W. Miles.

5

DIAGNOSIS AND THERAPY

Atkinson, W. S. **Preanesthetic sedation and analgesia for intraocular operations**

done with local anesthesia. A.M.A. Arch. Ophth. **49**:481-490, May, 1953.

The use of a combination of nembutal, demerol, and an anti-histaminic is suggested for careful preanesthetic preparation and medication. A test dose is given at least one day preoperatively and if no untoward effect is noted, the drugs are repeated one and one-half to two hours preoperatively. G. S. Tyner.

Funder, W. **Ultrasound therapy of ocular diseases.** Klin. Monatsbl. f. Augenh. **122**:683-692, 1953.

Twenty patients were treated with ultrasound. The frequency was 500, 800, or 1200 kHz. Glycerol was the contact fluid and the lids remained closed. Seven cases of vitreous hemorrhages were treated. There was slightly improved absorption, but recurrences were frequent. A case of acute glaucoma remained uninfluenced and in chalazia the results were equivocal. A pseudo-tumor of the orbit improved markedly. (16 references) F. Blodi.

Harrington, D. O. **Perimetry with ultraviolet (black) radiation and luminescent test objects.** A.M.A. Arch. Ophth. **49**:637-642, June, 1953.

The author describes his new device for the use of luminescent test objects for visual field examination. The apparatus utilizes ultraviolet radiation between 320 and 380μ, which is below the visible spectrum. The light is directed against the screen or perimeter. Only the fixation point and test object appear illuminated. The test objects are printed in luminescent sulfide ink which, when exposed to the light source, transforms the invisible radiation into white, red, green, or blue color. The objects appear as pure light against a black void. A scotoma may be plotted at two meters with a test object of only 0.25 mm. (The device is manufactured by Jenkel-Davidson Optical Company of San Francisco, California.) George S.Tyner.

Jaeger, W. **A new instrument for orbitonometery.** Klin. Monatsbl. f. Augenh. **122**:565-572, 1953.

This tonometer is fixed on the zygomatic and the frontal bone. The weights (100 and 200 gm.) are applied with a spring on a contact glass on the eye. Two measurements are made on each eye. The orbital resistance was found to be increased in thyrotrophic, but not in thyrotoxic exophthalmos. This corroborates the findings of Copper. The resistance is much greater in exophthalmos caused by an orbital tumor than in cases of orbital inflammations. In orbital angiomas the resistance decreases during the first 10 seconds and shows pulsation. (13 figures, 12 references) Frederick C. Blodi.

Lisch, K. **Heptadon-ephedrine-scopolamine in ocular surgery.** Klin. Monatsbl. f. Augenh. **122**:573-576, 1953.

Heptadon is an analgesic which has a spasmolytic side effect and suppresses coughing. Scopolamin depresses the motor centers, while ephedrine neutralizes the deleterious effects of scopolamin. This combination has been found very helpful as a preoperative medication in 114 cataract operations and in other forms of ocular surgery. (7 references) Frederick C. Blodi.

Scheerer, R. **Mycotin-ointment in penicillin eczema.** Klin. Monatsbl. f. Augenh. **122**:741, 1953.

The author has used this ointment, which contains undecelic acid and thioglycolic acids, with good results. Frederick C. Blodi.

Witmer, R. **Middlebrook-Dubos test and electrophoresis of the serum in ocular diseases.** Klin. Monatsbl. f. Augenh. **122**:641-654, 1953.

The sera of 140 patients with various ocular diseases were tested with the tuberculin I.P.48 of the Pasteur Institute, according to the hemagglutination test of Middlebrook. The same sera were examined with electrophoresis. Among 18 patients thought to have ocular tuberculosis, the Middlebrook test was positive in 15 cases; it was negative in 20 out of 122 patients with no clinical tuberculosis. If the Middlebrook test is positive and if the other clinical signs and laboratory tests warrant a diagnosis of tuberculosis, specific antituberculous therapy gave excellent and quick results in 70 per cent of the patients.

The Middlebrook test was then done with the aqueous, which was inactivated and pretreated with sheep's red blood cell. In cases of ocular tuberculosis the titer of the Middlebrook test is much higher than in the serum (relative always to the content of gamma globulins), while the titer for other antigens remains relatively the same as in the serum. It must therefore be concluded that these antibodies are produced in the eye, and that such a dissociation of titers is an absolute proof of ocular tuberculosis.

Electrophoresis of the sera of patients with tuberculosis (and other chronic infections) shows an increase of the gamma globulins. This could not be shown in patients with ocular tuberculosis. (10 references) F. Blodi.

7

CONJUNCTIVA, CORNEA, SCLERA

Bocci, G. **Pollen allergy of the conjunctiva.** Boll. d'ocul. **32**:163-167, March, 1953.

Pollen extracts from 25 plant species were instilled into the conjunctiva of one eye of rabbits twice daily for 15 consecutive days. One month after this preparation the same extracts were instilled into the conjunctiva of both eyes and injected intravenously. No allergic reactions were observed. K. W. Ascher.

Friede, R. **Medical and surgical treatment and prophylaxis of familial corneal dystrophies.** Klin. Monatsbl. f. Augenh. **122**:535-545, 1953.

The author theorizes on the hypothesis that a congenital hypofunction of Bowman's membrane and of the epithelium causes the corneal opacities in familial dystrophies and that this hypofunction decreases the permeability of these membranes. Treatment consists of subconjunctival injections of sugar or of the instillation of dextrose into the conjunctival sac. If the vision decreases, keratoplasty is indicated. A prophylactic lamellar keratoplasty could be considered before the corneal opacities develop. (9 figures) Frederick C. Blodi.

Jones, I. S., and Reese, A. B. **Focal scleral necrosis.** A.M.A. Arch. Ophth. **49**:633-636, June, 1953.

In three cases of focal necrosis of the sclera the lesion was due to focal application of irradiation to the sclera or limbus. The lesion is characterized by a punched-out hole surrounded by an avascular area. The dosage of gamma or beta irradiation was never in excess of the commonly used dosage. Eighteen and four years elapsed after treatment with gamma radiation, while only six weeks elapsed between the initiation of beta therapy and the appearance of an ulcer. George S. Tyner.

Kornblueth, W., Laufer, A., Loebel, E., and Frisher, M. **Fibrinoid degeneration of the tarsal conjunctiva.** A.M.A. Arch. Ophth. **49**:671-674, June, 1953.

In the case reported, an excised tumor mass of the tarsal conjunctiva proved to be local fibrinoid degeneration of collagen. The patient had trachoma in the cicatricial stage. George S. Tyner.

Losche, W. **Possibilities of an enzyme therapy of the eye.** Klin. Monatsbl. f. Augenh. **122**:741-742, 1953.

The author theorizes on the possibility of using tryptic enzymes for corneal ulcers. This method is certainly more gentle than any mechanical cleaning.

Frederick C. Blodi.

Nañagas, P. J. **Nutritional dystrophy of corneal epithelium.** A.M.A. Arch. Ophth. **49**:536-552, May, 1953.

In a clinical study of 41 cases of nutritional dystrophy of the corneal epithelium believed due to a vitamin B deficiency, the outstanding symptoms were foggy vision and mild photophobia. The objective findings were grayish, superficial punctate lesions closely grouped in the pupillary area. There were no inflammatory signs. The parenteral administration of vitamin B complex is beneficial. G. S. Tyner.

Pau, H. **Corneal dystrophy with progressive iris atrophy and glaucoma.** Klin. Monatsbl. f. Augenh. **122**:732-736, 1953.

In a case of iris atrophy with formation of holes, secondary glaucoma and bullous keratitis followed. A trephine operation made the situation worse but an abrasion of the corneal epithelium with conjunctival flap relieved the pain. (21 references)

F. Blodi.

Redi, F. **The possible herpetic etiology of deep corneal ulcers.** Arch. di ottal. **57**:103-109, March-April 1953.

A case of parenchymatous infiltration and edema of the cornea, without loss of substance, in an eye which had undergone eight attacks of dendritic keratitis during a period of 18 years is described. Mydriatics, cortisone and salycilates failed to alleviate the very painful condition and 24 hours later a large, deep ulcer had formed. Cortisone was stopped and penicillin, chloramphenicol, sulfonamides, aureomycin and terramycin were given without influencing the ulcer. Smears were negative. Inoculation of a rabbit cornea, however, was positive. Treatment was changed to mydriatics, penicillin and lysozyme, and the ulcer began to epithelialize. The final result is not mentioned. It is concluded that the etiologic agent of this corneal ulcer was the herpes virus.

John J. Stern.

Rezende, C. B. **Partial penetrating keratoplasty in keratoconus.** Arq. brasil. oftal. **15**:45-55, 1952.

Central corneal opacification in keratoconus is an indication for surgery. When vision is reduced to 0.1 with correction, although the cornea is transparent, an operation is indicated even if there has been some improvement with contact lenses. Eight case histories, with photographs, are reported from an anatomical and functional point of view. In three of the eight there was an excellent result.

Rezende prefers to use the corneal trephine and Elschnig suture and considers it essential to use a loupe, as magnification facilitates coaptation of the transplant. Anesthesia and akinesia are employed as in cataract surgery and maximum mydriasis is desirable to avoid post-operative synechiae which lead to opacification of the graft.

The donor eye is from a cadaver, refrigerated no more than 24 to 36 hours. Extreme care is required to maintain the integrity of Descemet's membrane. Injury to the crystalline lens must be avoided. A binocular dressing and bed rest are required. First dressing is on the seventh day, and the sutures are removed on the twelfth day. The patient is allowed out of bed on the fifteenth day.

Postoperative complications are well known and discussed at great length in the literature. A dislocation observed the first month after surgery is not considered fatal as the tissues frequently become im-

bibed with fluid. Degeneration is a grave complication; placental implantation or therapy with pre-ocular fluid according to a technique of Vidal are suggested.

James W. Brennan.

Riehm, W. **The pathogenesis of the so-called conjunctival tuberculoma and of Boeck's sarcoid.** Klin. Monatsbl. f. Augenh. **122**:657-664, 1953.

The author believes that conjunctival tuberculoma arises in the subconjunctival tissue. He supposes that the growth of these lesions occurs by the specific fixation of abortive metastases of non-viable bacilli in chronic bacillemia and that it is a part of a focal tuberculosis. (10 references)

F. Blodi.

Ruedemann, A. D. **Allergy of the cornea and bulbar conjunctiva.** Tr. Am. Acad. Ophth. **57**:471-475, May-June, 1953.

The author discusses various types of allergies that he has treated with medication, beta irradiation, or removal of the irritating substance.

Theodore M. Shapira.

Sommer, G. **New experiments in corneal alloplasty.** Klin. Monatsbl. f. Augenh. **122**:545-554, 1953.

The author has tried to replace a cloudy cornea with a glass window in animal experiments. This was tried in four patients after regular keratoplasty had failed. In the fourth patient the glass window was still retained eight months after the operation. (5 figures, 10 references)

Frederick C. Blodi.

Thiel, H. L. **Treatment of epidemic keratoconjunctivitis.** Klin. Monatsbl. f. Augenh. **122**:609-610, 1953.

During the fall of 1952 new epidemics of keratoconjunctivitis occurred in West Germany. The antibiotic Tyrosolvin instilled every two hours was a great value in 80 patients. (8 references)

Frederick C. Blodi.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Celeste, J. C., and Krug, A. **Cyst of the anterior chamber.** Arq. brasil. oftal. **15**:56-62, 1952.

Cysts of the iris have been known since 1830. Their etiology cannot always be determined. In addition to the aforementioned causes, cysts may be congenital, exudative or degenerative, spontaneous, or due to trauma, surgery or parasites.

Penetrating wounds or surgical intervention may permit the introduction of epithelial cells into the anterior chamber, which proliferate until cyst formation results. The majority of these cysts are serous and are generally located near the limbus. They have a thin wall, are often irregular in shape, and may be uni- or multiocular. Growth occurs in the direction of least resistance, until the pupillary aperture is covered. Slitlamp examination will reveal vessels growing from corneal substance at the site of the wound into the wall of the cyst. The posterior wall of the cyst is often composed of superficial iris tissue. There are three stages of growth: 1. without ocular symptoms or visual disturbances, 2. characterized by iridocyclitis, and 3. glaucoma and loss of vision requiring surgical intervention. An early diagnosis is essential. This is not always easy and requires a most careful history regarding trauma and growth of the cyst. Differential diagnosis includes nodular iritis and tumor formation. Iridectomy may be required for histological examination.

When the lesion is small and before there is much infiltration of the tissues, excision of the cyst in an iridectomy is indicated. In larger cysts, removal may be followed by irradiation. Other recommended procedures are aspiration of the contents followed by injection of iodine into the cavity, irrigation of the cavity with phe-

nol, and destruction of the cyst by diathermy.

A case is described in which a cyst of the anterior chamber developed in an eye which had an intracapsular cataract extraction followed by two small iris prolapses, which were cauterized. One year later, cyst formation associated with glaucoma was observed. The cyst was excised with a broad iridectomy. Histologic examination confirmed the diagnosis of cyst of the anterior chamber, with an epithelial structure resembling conjunctival tissue.

James W. Brennan.

Kleinert, H. **Vital staining of the aqueous and its epibulbar outflows after injecting fluorescein into the anterior chamber.** Klin. Monatsbl. f. Augenh. **122**:665-682, 1953.

The author injected 0.1 percent fluorescein into the anterior chamber of normal human eyes. The intraocular pressure increased markedly for a short period of time in most cases. The system of aqueous veins was then observed with the slit-lamp. An ultraviolet filter was placed before the illuminating system and a red-green filter in front of the ocular. The aqueous veins will only be visible when the intraocular pressure after the injection is higher than before. All the small branches and their anastomoses become visible. The blood influx phenomenon of Ascher could be observed in greater detail. The blood does not reach Schlemm's canal but is detoured into adjacent aqueous vein systems. (7 figures, 23 references) F. Blodi.

Stagni, S. **The pupil in heterochromia (Fuchs).** Boll. d'ocul. **32**:168-185, March, 1953.

Eighteen patients with heterochromia were studied by instillation of 2 percent adrenaline ointment with 5 percent nupercaine, 4 percent cocaine, 1 percent pilocarpine and ½ percent eserine solution. The pupils of the affected eyes showed lesser mydriatic effects after adrenaline-nupercaine and cocaine than the normal pupils did. A table indicating the presence of precipitates, the degree of iris atrophy, condition of the lens, size of pupil before and after medication is given. The course of the pupillary changes is illustrated in four graphs. The difference in reaction of the normal and heterochromic iris may be caused by severe tissue degeneration; paresis of the sympathetic nerve was ruled out. (References) K. W. Ascher.

Zwiauer, A., Deutsch, E., and Streit, M. **Involvement of the whole body in iridocyclitis.** Klin. Monatsbl. f. Augenh. **122**:655-657, 1953.

In patients with iritis or iridocyclitis the authors frequently found an increased permeability of the vessels and a reversal of the albumin-globulin ratio. (4 references)

F. Blodi.

9

GLAUCOMA AND OCULAR TENSION

Lohlein, H. **Dextrose bath in increased intraocular pressure.** Klin. Monatsbl. f. Augenh. **122**:599-605, 1953.

Twenty-four patients with various types of glaucoma received a 50 percent glucose solution as a corneal bath for 20 minutes. In most of the eyes the cornea could be cleared and the intraocular pressure reduced. Three patients with secondary glaucoma had a rise in tension. (6 figures, 8 references)

Frederick C. Blodi

10

CRYSTALLINE LENS

Kassner, H. **Unusually severe allergic reaction after cataract extraction.** Klin. Monatsbl. f. Augenh. **122**:736-738, 1953.

A 74-year-old woman had a severe allergic reaction after Septisol was instilled into the eye. It took months to heal. After

that, the cataract was extracted and the patient again had a severe allergic reaction which led to corneal opacities. (1 reference) F. Blodi.

11

RETINA AND VITREOUS

Bisland, T. **Vascular loops in the vitreous.** A.M.A. Arch. Ophth. **49**:514-529, May, 1953.

Six cases in which ophthalmoscopic examination disclosed vascular loops in the vitreous are reported. These loops are unrelated to the hyaloid circulation or postnatal disease. They undoubtedly represent congenital vascular anomalies.

G. S. Tyner.

Marsico, V. **A case of Jensen's retinochoroiditis, with a dental focus.** Arch. di ottal. **57**:73-83, March-April, 1953.

A typical case of Jensen's retino-choroiditis is described. Clinical, X-ray and laboratory examinations were negative. A dental examination revealed a granuloma and within a few days after its surgical removal marked improvement set in. Two weeks later the condition was considered cured with a small, pigmented retinal patch and a small paramacular scotoma remaining. John J. Stern.

Maumenee, A. E. **Diseases of the retina.** A.M.A. Arch. Ophth. **49**:553-586, May, 1953.

The pertinent literature for the year is abstracted. The major portion of the review is devoted to retrolental fibroplasia, retinal tumors, and vascular diseases.

G. S. Tyner.

Maumenee, A. E. **Diseases of the retina.** A.M.A. Arch. Ophth. **49**:675-710, June, 1953.

This is the concluding section of an extensive review of the subject and deals with diabetic retinopathy, retinal changes in toxemia of pregnancy, and general medical diseases. The tapetoretinal degenerations, macular lesions, retinal detachment and traumatic lesions of the retina are also reviewed. George S. Tyner.

Obal, A. **Fundus changes in tuberculous meningitis after streptomycin and isoniacid treatment.** Klin. Monatsbl. f. Augenh. **122**:584-599, 1953.

120 children with tuberculous meningitis were observed during the last four years in a Berlin hospital; 78 died. Twelve children were treated with streptomycin and isoniacid, or with isoniacid alone. This combined treatment leads to rapid general improvement but the fundus picture changes only slowly. The most frequent ocular change is an optic perineuritis, with marked field defects. A choked disc should be diagnosed only when the elevation of the disc surpasses two diopters. (11 figures, 27 references)

Frederick C. Blodi.

Ricci, A. **Filatow's therapy of retinosis pigmentosa.** Boll. d'ocul. **32**:134-146, March, 1953.

Twelve patients, between 10 and 61 years of age, observed for periods up to four years, showed transient improvements of vision, visual fields and, to a lesser degree, of light sense and color perception, during treatment as devised by Filatow. Rabbits, suffering from retinal degeneration after intravenous sodium iodide application, received a) Filatow therapy, b) vitamin E. There were no conclusive results from a histologic study of the retina. K. W. Ascher.

Salvi, G. L., and Cati, P. **Clinical study of the action of ACTH on retinosis pigmentosa.** Boll. d'ocul. **32**:147-162, March, 1953.

Twelve patients with retinosis pigmentosa received ACTH parenterally. The re-

sults were no more favorable than those obtained with a melanophore hormone therapy; the latter hormone is said to be present in the ACTH. Seven visual field schemes and a table showing visual acuity, visual fields, and the results of the Thorn test are given. K. W. Ascher.

Suarez Villafranca, M. R. **Macular cysticercus and exudative retinitis.** Arch. Soc. oftal. hispano-am. **13**:347-356, April, 1953.

A subretinal cysticercus was unsuccessfully removed, but was followed shortly by an exudative retinitis. In another case, previously reported, an exudative retinitis occurred in an eye in which a subretinal cysticercus had been diagnosed previously, but operation had been refused by the patient. Villafranca suggests that an intraocular parasite as the etiologic factor in cases of exudative retinitis be kept in mind. The two cases seen by the author indicate that the presence of the parasite within the globe for a short time can produce such lesions. (6 figures)

Ray K. Daily.

Wagener, Henry P. **Ophthalmology—retinal micro-aneurysms.** Am. J. M. Sc. **225**:219, Feb., 1953.

The literature is extensively reviewed and evaluated so that a considered opinion on the significance of retinal micro-aneurysm emerges. F. H. Haessler.

13

NEURO-OPHTHALMOLOGY

Harrington, D., and Flocks, M. **Ophthalmoplegic migraine.** Tr. Am. Acad. Ophth. **57**:517-530, July-Aug., 1953.

The pathogenesis of the disease is discussed and the pathologic findings in a case of recurrent oculomotor palsy are reported. Charcot's original definition of ophthalmoplegic migraine as "migraine associated with palsy of an ocular nerve" is still valid. The two clinical entities may be strikingly similar and classic migraine frequently merges into the ophthalmoplegic type. Anatomic, clinical, pathologic, and experimental evidence have been cited to prove that a unilateral increase in cerebral volume can produce ipsilateral herniation of the hippocampal gyrus of the temporal lobe through the incisure of the tentorium, resulting in recurrent homolateral oculomotor palsy, visual disturbances and hemicrania.

A case of recurrent oculomotor paralysis is reported, with the typical clinical symptom complex of ophthalmoplegic migraine. Autopsy findings revealed a marked herniation of the hippocampal gyrus with pressure on the third nerve. The hernia was secondary to unilateral cerebral edema produced by a brain tumor. The authors suggest that the symptom complex is produced by hippocampal gyrus herniation in susceptible individuals; that the herniation of the brain over the free edge of the tentorium is dependent on anatomic variations correlated with unilateral cerebral edema, and that the edema may be the result of intracranial volume changes, physiologic or pathologic in etiology. Theodore M. Shapira.

Harrington, D. O., and Flocks, M. **Ophthalmoplegic migraine.** A.M.A. Arch. Ophth. **49**:643-655, June, 1953.

The autopsy findings demonstrated the cause for a recurrent oculomotor paralysis. It was due to herniation of the right hippocampal gyrus, which exerted pressure on the right oculomotor nerve. The hernia was secondary to unilateral cerebral edema produced by a brain tumor.

George S. Tyner.

Lowenstein, O., Murphy, S. B., and Loewenfeld, I. E. **Functional evaluation of the pupillary light reflex pathways.** A.M.A. Arch. Ophth. **49**:656-670, June, 1953.

To determine the functional value of neurons which constitute the pathway of the pupillary light reflex, focal lesions were produced along the pathway in eighteen cats and the effect determined by pupillography. It was shown that contraction anisocoria is never due to lesions anterior to the pretectal area. Unilateral lesions in the afferent pathways always affect both pupils; unilateral lesions in the efferent pathways result in pupillary disturbances of the injured side only.

George S. Tyner.

Piper, H. **Eye symptoms in pathologic processes in the middle cranial fossa.** Med. Klin. **48**:1101-1104, July 31, 1953.

The author points out that clinically and diagnostically the orbit and the middle cranial fossa and their contents must be considered a unified region. He provides a useful commentary on the signs and symptoms which arise in these tissues.

F. H. Haessler.

14

EYEBALL, ORBIT, SINUSES

Kreibig, W. **Opticomalacia, a sequel of a retrobulbar obliteration of a vessel in the optic nerve.** Klin. Monatsbl. f. Augenh. **122**:719-731, 1953.

Opticomalacia is characterized by a sudden, often bilateral, decrease in vision in old patients. The disc is somewhat edematous, the arterioles are constricted, the veins are dilated and there are a few hemorrhages on or near the disc. Histologic examination of the optic nerve reveals an anemic infarct caused by the obliteration of the ophthalmic artery or its branches; it is due to a granulomatous arteritis. Eight cases are reported. In six a histologic examination of the temporal arteries revealed the typical picture of an arteritis. Opticomalacia belongs, therefore, to the entity of temporal arteritis. The clinical symptoms of the eye precede and outweigh all other signs and symptoms. (4 figures, 20 references) F. Blodi.

deVeer, J. A. **Bilateral endophthalmitis phacoanaphylactica.** A.M.A. Arch. Ophth. **49**:607-632, June, 1953.

Three cases of bilateral endophthalmitis phacoanaphylactica are reported, with special emphasis on the anatomic characteristics of one enucleated eye in each case. The anatomic findings in each case confirm the belief that rupture of the lens capsule is perhaps invariably present in one eye in cases of the unilateral form, and in both eyes in cases of the bilateral form. Antecedent trauma does not appear to be a prerequisite for development of the disease. Suggestions for diagnosis and therapy include skin testing in suspected cases, removal of the lens of the affected eye when the skin test is positive, and desensitization after extracapsular cataract extraction when only one eye is affected. George S. Tyner.

15

EYELIDS, LACRIMAL APPARATUS

Burch Barraquer, Manuel. **A contribution to the surgery of the lacrimal canaliculus.** Arch. Soc. oftal. hispano-am. **13**:357-375, April, 1953.

The author's experience with 13 cases of stenosis of the lacrimal canaliculus is given. Five patients had stenosis of the lacrimal sac associated with stenosis of the canaliculus. A dacryocystotomy was combined with the construction of a new canaliculus with a pedicled conjunctival flap. The flap, attached below the caruncle, was cut from the upper portion of the globe, wrapped around a heavy silk suture and inserted through an opening in the conjunctival sac into the lacrimal sac, and held there for 15 to 20 days. The results were good in three cases; in one the epiphora was diminished; the fifth was a failure because the new canaliculus was too

short. Five cases had stenosis of the lacrimal sac, with a mild stricture at the junction of the canaliculi. The dacryocystostomy was concluded by the insertion of a heavy silk suture through the inferior canaliculus. It remained within the canaliculus for 15 to 20 days. Four patients were cured; in one there was a recurrence of epiphora 12 days after this suture was removed. Three patients had an obstruction of the common portion of the canaliculus, with normal lacrimal sacs. The fundus of the lacrimal sac was transplanted into the conjunctival sac, successfully in two cases, and unsuccessfully in one. (20 figures) Ray K. Daily.

Fazakas, S. **Mycotic diseases of the ocular adnexa.** Klin. Monatsbl. f. Augenh. **122**:559-565, 1953.

Nine cases of obstruction of a lacrimal duct by fungus colonies are described. Eight cases of mycotic blepharitis were observed. They were caused by trychophyton, favus and other fungi. (16 references) Frederick C. Blodi.

Sertorio, S., and D'Almeida, B. **Treatment of acute dacryocystitis by nasal drainage.** Arch. Soc. oftal. hispano-am. **13**:376-385, April, 1953.

The technique of intranasal dacryocystostomy which is applicable to acute inflammations of the lacrimal sac is described. The author operates in cooperation with a rhinologist. His results were completely successful. (12 figures) Ray K. Daily.

Sjøgren, H. **Congenital lack of lacrimation and keratoconjunctivitis sicca in children.** Klin. Monatsbl. f. Augenh. **122**:554-559, 1953.

Congenital lack of lacrimation may be caused by various factors. Usually it is a central disturbance (familial dysautonomia), sometimes a lack of nervous connections (as in newborn children), and occasionally a congenital aplasia of the lacrimal gland. (25 references) Frederick C. Blodi.

16
TUMORS

Carreras Matas, Marcelo. **An unusual postoperative recovery of vision in a patient with Cushing's syndrome.** Arch. Soc. oftal. hispano-am. **13**:386-392, April, 1953.

The author reports a case of suprasellar meningioma, of two years duration, in a woman 50 years old, which was removed surgically. Three years after the operation the right eye recovered a visual acuity of 5/50 from a preoperative of 3/50, and the left eye improved from hand movements to a visual acuity of 1/2. The visual fields, which preoperatively had been greatly constricted in the left eye, with a temporal hemianopsia in the right, recovered completely, leaving only a bitemporal constriction demonstrable by a test of 2/2000 on the Bjerrum screen. (5 figures) Ray K. Daily.

Knauer, R. **Uveal metastases from a carcinoma of the breast in a male.** Klin. Monatsbl. f. Augenh. **122**:606-609, 1953.

A 49-year-old man developed a nodule in the iris and ciliary body of the left eye four years after a radical mastectomy. The patient died two months later and histologic examination revealed another metastasis in the choroid of the same eye. Frederick C. Blodi.

17
INJURIES

Jaffe, N. S., and Durkin, L. S. **Geniculocalcarine injuries in war casualties.** A.M.A. Arch. Ophth. **49**:591-606, June, 1953.

In twelve cases of head injury with resultant visual field defects due to traumatic lesions of the geniculocalcarine

tracts, congruity was the most important sign of posterior lesions. Sparing of the macula was not a reliable sign. In cases of trauma the macula is usually split, but central visual acuity remains good. Occipital lesions are usually "silent" but radiation lesions are commonly associated with other signs and symptoms. Optic atrophy occurs slowly following subgeniculate lesions. Small homonymous defects strongly indicate cortical or subcortical damage. George S. Turner.

Schmoger, E. **Pontocaine damage.** Klin. Monatsbl. f. Augenh. **122**:527-535, 1953.

Five patients had severe corneal damage after indiscriminate use of pontocain. All ophthalmologists agree that drops containing cocaine, or pontocaine, should not be given to the patient. However, such prescriptions still appear in some textbooks of pharmacology. (34 references)
Frederick C. Blodi.

Thies, O. **Treatment of severe chemical burns of the eye.** Klin. Monatsbl. f. Augenh. **122**:513-526, 1953.

At the present time many physicians prefer conservative treatment of chemical injuries to the conjunctiva and the cornea. They are especially favorably impressed by the early and continuous use of strong vasodilators such as acetylcholine, priscol, vasculat and others. The author believes that in severe injuries early surgical intervention remains the method of choice. It is important to excise the necrotic conjunctiva. The defect can be closed directly or it can be covered by a graft from the other conjunctiva or by a mucous membrane graft from the lips. (20 figures)
Frederick C. Blodi.

18

SYSTEMIC DISEASE AND PARASITES

Hauser, S. A. **Diagnosis and treatment in ocular allergy.** Tr. Am. Acad. Ophth. **57**:476-481, May-June, 1953.

Most patients who have any form of ocular allergy also have allergic manifestations in other parts of the body, such as 1. a slow pulse, 2. low blood pressure, 3. spastic gastrointestinal tract, 4. increased eosinophilia, and 5. lowered basal metabolic rate. In testing for allergies, history, provocative tests, conjunctival tests, patch tests, skin tests, and injection tests are used. In chronic conjunctivitis, cortisone is used locally in the eye as drops, or given systemically. The author discusses the use of cortisone and hydrocortisone in the treatment of allergies and in chronic recurrent marginal blepharitis, phlyctenular keratoconjunctivitis and vernal conjunctivitis.
Theodore M. Shapira.

Krysta, F. **Ocular involvement in temporal arteritis.** Klin. Monatsbl. f. Augenh. **122**:739-741, 1953.

A case of sudden blindness in one eye is reported. Biopsy of the temporal artery gave the characteristic picture. (5 references) Frederick C. Blodi.

Payne, B. F. **Pathologic findings in allergic diseases of the eye.** Tr. Am. Acad. Ophth. **57**:468-470, May-June, 1953.

Vernal conjunctivitis, phlyctenular conjunctivitis and the various granulomatous conditions of the eyes are thought to have allergic phases. Certain common granulomas of the eyes such as chalazion, tuberculosis, sarcoidosis, sympathetic ophthalmitis, syphilis and leprosy show some allergic phases at times. The author points out some of the characteristics of allergic tissue and stresses that antigens and antibodies are not recognized with the microscope nor are swollen and weeping tissues excised for histologic examination.
Theodore M. Shapira.

Theobald, G., and Wilder, H. **Heerfordt's syndrome.** Tr. Am. Acad. Ophth. **57**:332-333, May-June, 1953.

The authors present a case of parotitis, facial palsy and granulomatous iridocyclitis, similar to that first described by Heerfordt. Theodore M. Shapira.

19

CONGENITAL DEFORMITIES, HEREDITY

Anderson, B., and Woodhall, B. **Visual loss in primary skull deformities.** Tr. Am. Acad. Ophth. **57**:497-516, July-Aug., 1953.

Various and striking types of skull deformity may be caused by premature craniosynostosis. In more than one third of these deformities, and usually in oxycephaly, optic atrophy and diminution in visual acuity result. From a study of the extensive literature on this subject and of some of the cases in this report, the authors suggest that these deformities are conditioned by heredity. Visual disturbances are caused by an increase in intracranial pressure, secondary to the mechanical suppression of normal brain growth in the fused skull. Since brain growth is active during the first two years of life, operative treatment should be instituted during this time, to prevent visual loss as well as to correct the skull deformity. Linear craniectomy of, or adjacent to, the fused suture lines, with the regrowth of bone controlled by the application of polyethylene film to the craniectomy line, is the technique of choice. When craniosynostosis is recognized in the later years of childhood, vision may be markedly improved by operative intervention or at least further visual loss may be avoided. The authors studied the end result of untreated oxycephaly in six patients over 20 years of age. In five of these visual loss was profound. The conclusion seems clear that the prevention of visual damage in patients with premature craniosynostosis is related chronologically to the recognition and treatment of the disorder.

Theodore M. Shapira.

20

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Hefel, F. **The history of the treatment of amblyopia.** Klin. Monatsbl. f. Augenh. **122**:611-622, 1953.

Amblyopia is here defined as decreased vision without or with little organic defect. Occlusion of the better eye was first advised by Buffon in 1743 and was later again emphasized by Javal. At the turn of the century many ophthalmologists believed that amblyopia precedes strabismus. Worth's amblyoscope was a step forward. Fisher was one of the first who practiced active exercises of the amblyopic eye while the better eye was occluded. While most ophthalmologists and orthoptists now emphasize the importance of a continuous occlusion, a few European ophthalmologists still believe that occasional occlusion with active exercises may give better results. (62 references)

Frederick C. Blodi.

Junceda Avello, Juan. **Etiology and prophylaxis of blindness. Blind assistance for adults and children. Reeducation and rehabilitation. Statistics on national and foreign legislation.** Arch. Soc. oftal. hispanoam. **13**:393-433, April, 1953.

This is a comprehensive review of the activities of the various agencies that deal with the problem of blindness. In Spain there is much to be done in education and social service. The specific recommendations are: 1. The establishment of a criterion of blindness based not only on visual acuity, but also on visual fields and other visual functions. 2. A census of the blind, to be utilized in the planning of services. 3. Revision of the census at least every three years to determine the effectiveness of the campaign against blindness. 4. Intensification of prophylaxis against blindness by dispensaries and specialized services, especially in the rural areas. 5. Preschool and school visual

examination by competent personnel. 6. Supervision of dangerous industries by an ophthalmologic staff. 7. Publication of a guide for the training of blind children. 8. Compulsory attendance of blind children in schools for the blind. 9. Setting up of local rehabilitation committees. 10. Legislation requiring large industries to employ a certain percentage of blind persons who have been trained for the job. 11. To reserve for the hopelessly blind the right of selling stamps and tobacco. 12. The creation of a Latin association for the prevention of blindness.

Ray K. Daily.

Koch, Carel C. **Cycloplegics and mydriatics—what position should optometry take if asked to use them?** Am. J. Optometry **30**:382-385, July, 1953.

The editor of the Am. J. Optometry states that public health officers, educators, and certain ophthalmological leaders will at some future time urge optometrists to use cycloplegic drugs in some refractions, mydriatics in some examinations, and surface anesthetics for tonometry. In some military clinics, this procedure is now routine. Optometrists should decide whether the use of such drugs would provide better service for the public.

Paul W. Miles.

Larsson, Sven. **Notes on ophthalmological practice in Lund.** Brit. J. Ophth. **37**:257-266, May, 1953.

Cataract extraction has been by intercapsular method the past few years although it is felt that the extracapsular method should be preferred by the infrequent operator. A plea is made for routine bacteriological examination in every case before surgery. Hypermature cataract is probably encountered more than usual in Sweden because of a natural reluctance of the older people to submit to surgery. Operation is urged as soon as possible to prevent secondary glaucoma. Bone-free radiography for small foreign bodies is recommended. The eyeball is pulled out of the socket as far as possible; when necessary one or more of the extraocular muscles are cut. The plate is actually placed behind the posterior pole of the eyeball, and very accurate localization of the foreign body can be made. In the operation for repair of retinal detachment little change has been introduced since 1930, except that the subretinal fluid is aspirated rather than merely drained through a scleral trephine opening.

Morris Kaplan.

NEWS ITEMS

Edited by Donald J. Lyle, M.D.
601 Union Trust Building, Cincinnati 2

News items should reach the editor by the 12th of the month, but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received at least three months before the date of occurrence.

Deaths

Dr. Henry Bacon Abbott, Geneva, New York, died July 23, 1953, aged 39 years.

Dr. James Magee Blackwood, New Castle, Pennsylvania, died June 25, 1953, aged 76 years.

Dr. George W. Mahoney, Wilmette, Illinois, died June 11, 1953, aged 92 years.

Dr. Frederick C. Stahlman, Indiana, Pennsylvania, died July 15, 1953, aged 84 years.

Announcements

East-Central Research program

The East-Central Section of the Association for Research in Ophthalmology will meet on Monday, January 4, 1954, at the Mellon Institute, Pittsburgh, Pennsylvania. Registration will be at 8:00 a.m., and on the program starting at 8:30 a.m. will be the following papers:

"Experimental iso-allergic uveitis in rabbits," T. Suie, Ph.D.; M. C. Dodd, Ph.D.; H. Farmer, M.D.; W. D. Rummel, M.D.; and A. M. Culler, M.D., Department of Ophthalmology, Ohio State University, Columbus, Ohio.

"Ocular affections produced by trigeminal nerve lesions," Donald J. Lyle, M.D., Department of Ophthalmology, University of Cincinnati, Cincinnati, Ohio.

"Ophthalmological manifestations of primary amyloidosis," Harold F. Falls, M.D., Department of Ophthalmology, University of Michigan, Ann Arbor, Michigan.

"Structure of the visual cells as demonstrated by the phase microscope and the electron microscope," Roy W. Teed, M.D., Department of Ophthalmology, Ohio State University.

"Research in photoreceptors," Jerome J. Wolken, Ph.D., Biophysics Research Laboratory, Department of Ophthalmology, University of Pittsburgh and Eye and Ear Hospital.

"An experimental study of electroretinography: I. The electroretinogram in experimental animals under the influence of methanol and its oxidation products," J. Praglin, R. Spurney, and A. M. Potts, M.D., Laboratory for Research in Ophthalmology, Western Reserve University, Cleveland, Ohio.

"Studies on the visual toxicity of methanol: V. The role of acidosis in experimental methanol poisoning," A. P. Gilger, M.D. and A. M. Potts, M.D., Western Reserve University.

"Studies on the visual toxicity of methanol: VI. The clinical picture of methanol poisoning in monkeys treated with base," A. M. Potts, M.D., Western Reserve University.

"An evaluation of di-ethyl-p-nitrophenyl phosphate (mintacol): A new anticholinesterase agent," Raymond L. Brewer, M.D., and Jay G. Linn, Jr., M.D., Veterans Hospital, Aspinwall, Pennsylvania, and Department of Ophthalmology, University of Pittsburgh.

"Multiple stress and intraocular hypertension," Ernst Schmerl, M.D., and Bernhard Steinberg, M.D., Toledo Hospital Institute for Medical Research, Toledo, Ohio.

"Localization of the effect of galactose in the production of cataracts," John W. Patterson, M.D., Western Reserve University.

"A new method for studying the equatorial region of the crystalline lens," Harvey E. Thorpe, M.D., Department of Ophthalmology, Montefiore Hospital, Pittsburgh, Pennsylvania.

"A study of dynamic visual acuity," Elek Ludvigh, director of research, Kresge Eye Institute, Detroit, Michigan.

"Standardization of optotypes," J. H. Prince, Department of Ophthalmology, Ohio State University.

"Sensitivity variations in the visual field as a function of background luminance," H. R. Blackwell, Ph.D., and A. B. Moldauer, Vision Research Laboratory, University of Michigan.

"A new scintillation probe for use in ophthalmology," Joseph F. Nechaj, Addison H. Gibson Laboratory, University of Pittsburgh.

"Effect of alcohol on binocular vision," Gerhard A. Brecher, M.D., E. Q. Adams, A. P. Hartman, and D. D. Leonard, Department of Physiology, Western Reserve University School of Medicine.

"A self-recording tangent screen," William U. McReynolds, M.D., University Hospital, Ann Arbor, Michigan.

"Comparison of standard and flicker perimetry," William H. Havener, M.D., John W. Henderson, M.D., University Hospital, Ann Arbor, Michigan.

"Anatomy of the macula and visual phenomena related to its structure," David Volk, M.D., Cleveland Heights Medical Center.

Memphis meeting

February 6, 7, and 8, 1954, are the dates of the annual convention of the Memphis Eye, Ear, Nose, and Throat Society. Guest speakers at this meeting will be Dr. Daniel B. Kirby, New York; Dr. Lewis F. Morrison, San Francisco; Dr. Jerome A. Hilger, Saint Paul; Dr. Charles A. Perera, New York; Dr. John M. Converse, New York; and Dr. Kenneth C. Swan, Portland, Oregon.

Research Study Club

Guest lecturers for the eye program at the 23rd annual midwinter clinical convention of the Research Study Club of Los Angeles, January 18 through 29, 1954, will be Dr. Daniel B. Kirby, New York; Dr. Frank D. Costenbader, Washington, D.C.; and Dr. George N. Hosford, San Francisco. Other lectures and instruction courses in ophthalmology will be given by Dr. Harold B. Alexander, Pasadena; Dr. Paul Henry Case, Phoenix; Dr. Donald B. Lindsley and Dr. Robert B. Livingston, Los Angeles, and Dr. Dwight H. Trowbridge, Fresno. The round-table luncheons, as in the past, will be the heart of the convention.

The fee for the course, or any part of it, is $100.00 payable to Dr. Pierre Violé, treasurer, 1930 Wilshire Boulevard, Los Angeles 57. Each applicant must be a member in good standing of the American Medical Association. For reservations for a place to stay write to Mr. H. M. Nickerson, manager of the Elks Club, 607 South Parkview Street, Los Angeles 57.

Florida midwinter seminar

The eighth annual University of Florida Midwinter Seminar in Ophthalmology and Otolaryngology will be held at the San Souci Hotel in Miami Beach the week of January 18, 1954. The lectures on ophthalmology will be presented on January 18th, 19th, and 20th, and those on otolaryngology on January 21st, 22nd, and 23rd. A midweek feature will be the midwinter convention of the Florida Society of Ophthalmology and Otolaryngology on Wednesday afternoon, January 20th, to which all registrants are invited. The registrants and their wives may also attend the informal banquet at 8:00 p.m. on Wednesday. The seminar schedule permits ample time for recreation.

The seminar lecturers on ophthalmology this year are Dr. W. B. Anderson, Durham, North Carolina; Dr. W. P. Beetham, Boston; Dr. W. C. Owens, Baltimore; Dr. A. B. Reese and Dr. M. C. Wheeler, New York; Those lecturing on otolaryngology are Dr. E. N. Broyles, Baltimore; Dr. H. P. House, Los Angeles; Dr. W. J. McNally, Montreal, Canada; Dr. Dorothy Wolff and Dr. D. Woodman, New York.

International symposium on general physiology and pathology of the eye

Following the International Congress of Ophthalmology and the meeting of the American Academy of Ophthalmology and Otolaryngology in New York, an International Symposium on the General Physiology and Pathology of the Eye will be held at the Department of Ophthalmology, College of Medicine, State University of Iowa, in Iowa City, Iowa.

This symposium will be held on September 24 and 25, 1954. The following guest speakers will participate: G. von Bahr (Sweden), G. B. Bietti (Italy), J. Boeck (Austria), H. Henkes (Holland), G. B. J. Keiner (Holland), H. K. Mueller (Germany) and E. Wolff (England). All papers and discussions will be in English. The detailed program will be announced at a later date.

Wilmer clinical meeting

The 13th clinical meeting of the Wilmer Residents Association will be held at the Wilmer Ophthalmological Institute of The Johns Hopkins Hospital on April 1, 2, and 3, 1954.

Stanford postgraduate conference

Stanford University School of Medicine will present the annual postgraduate conference in ophthalmology from March 22 through March 26, 1954. Registration will be open to physicians who limit their practice to the treatment of diseases of the eye or eye, ear, nose, and throat. In order to allow free discussion by members of the conference, registration will be limited to 30 physicians.

Instructors will be Dr. A. Edward Maumenee, Dr. Dohrmann K. Pischel, Dr. Jerome W. Bettman, Dr. Max Fine, Dr. Earle H. McBain, and Dr. Arthur J. Jampolsky.

Programs and further information may be obtained from the Office of the Dean, Stanford University School of Medicine, 2398 Sacramento Street, San Francisco 15, California.

Societies

Brooklyn meeting

On the scientific program of the 125th regular meeting of the Brooklyn Ophthalmological Society were Dr. Arthur E. Sherman, who spoke on "Ptosis surgery"; Dr. Nicholas P. Tantillo, "Presentation of two cases of intraocular mass"; Dr. J. Arnold de Veer, "Discussion and pathologic presentation."

Officers of the society are: President, Dr. Donald E. Swift; vice-president, Dr. Louis Freimark; secretary-treasurer, Dr. George A. Graham; associate secretary-treasurer, Dr. Nicholas P. Tantillo.

International Organization against Trachoma

A meeting of the council was held on June 22, 1953, at Maison de Chimie, Rue St. Dominique, Paris.

Reference was made to the "Report on the treatment of trachoma by sulfonamides and antibiotics," recommended by a committee nominated by the World Health Organization, Geneva. Four members of the council took part: Professor Bietti (Italy), Dr. Pagès (Morocco), Dr. Nataf (Tunisia), and Dr. Maxwell Lyons (United Kingdom). The report was published in the *International Review of Trachoma*, Nov. 4, 1952.

Dr. P. Bailliart (France), and Prof. G. B. Bietti (Italy) were elected to the newly created posts of vice-presidents. Prof. Arnold Sorsby (Great Britain) was elected secretary general in place of Prof. Mulock Houwer, resigned. The following were elected as additional members of the council: Dr. Maxwell Lyons of the World Health Organization, Geneva; Dr. Phillips Thygeson (United States), and Dr. Busacca (Brazil).

In the afternoon a scientific meeting was held in conjunction with La Ligue Contre le Trachome at which discussions on various aspects of trachoma took place.

Reading meeting

Approximately 35 physicians attended the 136th meeting of the Reading Eye, Ear, Nose, and Throat Society. The speaker of the evening was Dr. A. Gerard DeVoe, professor and chairman, Department of Ophthalmology, New York University Post-Graduate Medical School. Dr. DeVoe presented an illustrated lecture on "An evaluation of plastic procedures about the eye."

A Study Club was conducted on "Epistaxis." Dr. Marvin Rothenberger, Allentown, was the moderator, Dr. John J. Penta and Dr. Philip R. Wiest, Reading, were instructors.

Personals

Dr. DuPont Guerry, III, has been appointed professor of ophthalmology and chairman of the Department of Ophthalmology, Medical College of Virginia.

Dr. Arnold H. Knapp, professor emeritus of ophthalmology, Columbia University, and consultant at The Presbyterian Hospital, New York, was one of 25 individuals who received Distinguished Service Medals at the 25th anniversary of the dedication of the Columbia-Presbyterian Medical Center.

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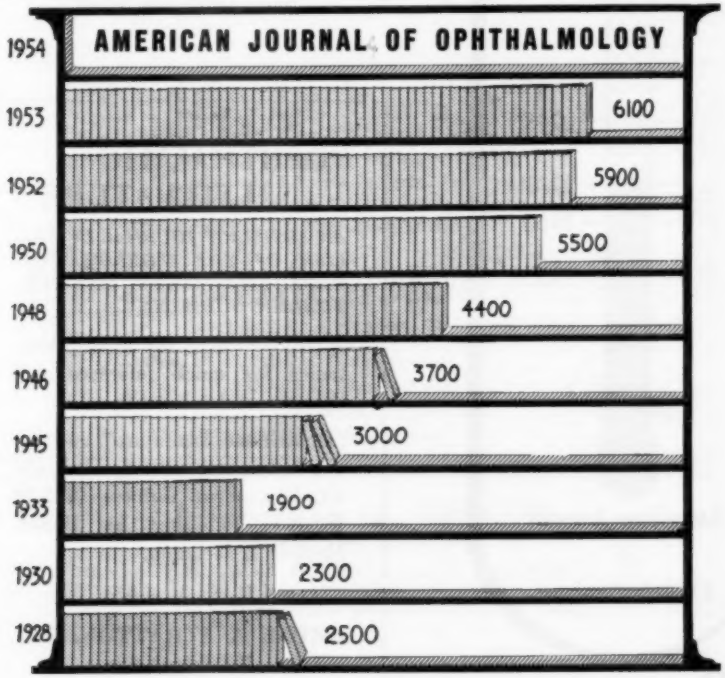

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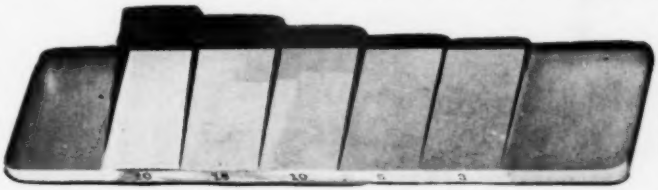

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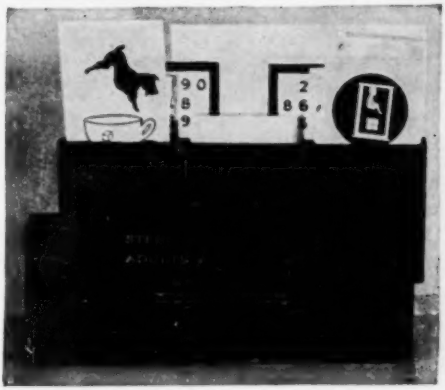

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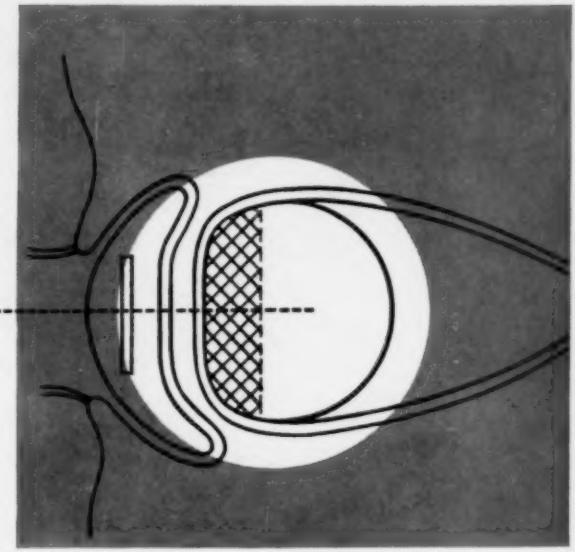

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